PROCEEDINGS

National Seminar on

Exploration of Indigenous Raw Materials for Essential Oil Industry

May 18-19, 1992

भारत ज्योति

Under the auspices of

Bharat Jyoti Perfumers & Growers Development Foundation, Lucknow

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FOREWORD

Essential oil industry is a fast growing industry and during the last few years it has made tremendous progress. While 20 years back the export of the essential oils and related products was worth about Rs. 5 crores, it has touched 105 crores in 1991-92. The internal demand has also likewise increased during the period.

Although essential oils are obtained from various sources, yet plants continue to be the main source. Indian flora is very rich in aromatic plants but so far only few plant species have been commercially exploited. Several Scientists and Organizations are seriously engaged in examining newer species to assess their potential for commercial exploitation, still a lot more needs to be done to meet the growing demand of essential oils.

In recent years researchers from the National Institutes and the Universities have contributed significantly in R & D of essential oils which may greatly benefit the industry. A liaison between the industry and the research institutes has to be established for this purpose. I am happy that Bharat Jyoti has been providing this link by bringing together the Scientists and entrepreneurs through organising seminars, meetings etc.

The contents of the present publication contain very useful information for the cultivators, manufacturers, traders and R & D workers of essential oils. Besides, scientific data, information on technology transfer, form of assistance from financial institutions and marketing scenario have been given. I hope this informative publication will help all those dealing in the essential oil trade. I congratulate the organisers of the Seminar for bringing out this booklet.

P.V. SANE
DIRECTOR
National Botanical Research Institute
Lucknow

Lucknow
December 5, 1992

PREFACE

Aromatic Plants and scented principles contained in them play a vital role in our day to day life. From morning to evening and birth to death man uses scented materials in one form or other, by way of flowers and insence for worship condiments for kitchen, flavours for toothpastes and toilettories. The list of their use is endless and space is less.

During the last three decades a lot of research work has been undertaken at various R & D institutes in the country which greatly helped the perfumery industry to upgrade the existing technology for production and develop new technology as well. It is difficult to list all the institutes or centres conducting R & D work on essential oils and aromatic plants; however the prominent are NBRI and CIMAP at Lucknow, Regional Research Laboratories at Jammu, Jorhat, Bhubaneshwar and Trivandrum, NCL, Poona, NBPGR, New Delhi, HRI, Bangalore, IIS, Bangalore, Tamilnadu Agricultural University, Coimbatore, Punjab Agriculture University, Ludhiana, Kerala Agricultural University, Cochin, Gujarat Agricultural University, Anand etc. Besides this work on essential oils is also being carried out at FRI, Dehradoon, HBTI, Kanpur, Cinchona Department, Tamilnadu and West Bengal. Industrial houses like Hindustan Lever Limited, Industrial Perfume Ltd., Camphor & Allied Industries, M/S Richardson & Hindustan Ltd., M/S S.H: Kelkar & Co., M/S Bush Boake & Allen etc. have established their own research and development units.

About 5,000 tons of essential oils are produced in India annually. The state of Uttar Pradesh has the greater share in this production. The major oil produced is mentha oil, about 2,500 tons annually. 1991 figures have touched to 3,000 tons. Other oils produced are vetiver, palmarosa, lemon grass, citronella and basil oil etc. Besides, some attars, blended compounds and perfumery chemicals are also produced. No doubt the production of essential oils in India has enhanced a lot during past few years, Major credit of this goes to R & D institutes and centres. Inspite of all this progress and user is not getting full benefit of these developments. The coordination between cultivators, distillers, producers, consumers and researchers is lacking. A need of some voluntary

organisation was long felt which may function as a sort of link between the scientists, technocrats and production agencies. BHARAT JYOTI, a voluntary social organisation of Lucknow took step in this direction and organised National seminar on "Scope of Essential Oil Industry in Uttar Pradesh" in April, 1990. The seminar was well attended by eminent scientists, cultivators, perfumers traders, experts from forest Department, financial institutions and sales tax department.

At the end of seminar it was recommended to form a "PERFUMERS & GROWERS DEVELOPMENT FOUNDATION" with headquarter at Lucknow bearing the aim to bring all the concerned agencies closer in order to promote the production and trade of essential oils and related products in the country. Its objectives had been-

1. To bring scientific awakening amongst the cultivators, traders and perfumers by holding penal meetings and seminars at various locations. This will provide opportunities for exchange of knowledge amongst members on the subjects concerning essential oil and allied industries.
2. To carry the research done in laboratories to farmers and consumers by holding training programmes and inviting various research labs./Institutes for the process demonstration.
3. To assist farmers & traders for availability of planting material and end products.
4. To supply desired information to R & D workers and producers.
5. Arranging for testing of samples for examination of products for quality control.
6. To collect information regarding essential oil trade in India and abroad for the convenience of traders industrialists and farmers.
7. To assist in procurement of financial assistance from various financial institutions.
8. Any other assistance needed from time to time.

The foundation held another national seminar on the "Exploration of Indigenous Raw Materials for Essential Oil Industry" at CIMAP, Lucknow on 18th & 19th May, 1992. The experts of all the agencies concerning essential oil production and trade, taxation and financial institutions participated and presented their papers.

I am extremely grateful to Dr. R.S. Thakur, Director, CIMAP and Dr. P.V. Sane, Director, NBRI, Lucknow, Dr. S.C. Dutta, Ex-Director, CIMAP, Lucknow for their active guidance and the functioning of foundation and organising the seminar and also for providing the facilities. I am thankful to His Highness Sh. Satya Naraina Reddi, Governor, Uttar Pradesh for his keen interest in our project; Dr. S.S. Dang, then minister of P.W.D., Government of U.P.; Sh. Aijaz Rizvi, then minister of Waqf and Civil Supplies, Government of U.P. for sparing time to participate in the deliberations of the seminar. Thanks are also due to U.P. State Council for Science & Technology (OUTCAST), Lucknow and Council of Scientific & Industrial Research (CSIR), New Delhi for Co-sponsoring the seminar. M/S M.L. Shukla & sons, Kanpur, M/S Dhingra Marketing Pvt. Ltd., Lucknow and C.G. & Company, Lucknow for sponsoring various items and our advertisers in the souvenir also deserve thanks.

I also thank Dr. O.P. Virmani, Dr. D.V. Singh, Dr. S.N. Garg, Dr. Sunil Kumar and their colleagues from CIMAP and Mr. M.L. Sharma, Dr. R.K. Khanna, Mr. B.D. Bhatt, Dr. R. Banerjee and their colleagues at NBRI for their sincere efforts and hard work in organising the seminar. Members of Bharat Jyoti and particularly Dr. Ajit Singh (Retd. Scientist RRL, Jammu), Mr. B.M. Arora, Mr. Vipin Bakshi, Mr. Rakesh Sharma and Mr. Amit Kumar who took active part to make this seminar a success are also thankfully acknowledged.

I also pay my gratitude to Dr. S.K. Jain, Dr. D.S. Bhakuni, Dr. M.C. Upreti for chairing various sessions and experts who presented the papers. Thanks are also due to the delegates and participants who came from far of places to take part in the seminar.

Lastly I thank Mr. Virendra Bari, Prop. Bharat Book Depot for helping in the publication of the proceedings of the seminar.

VIJAY ACHARYA
PRESIDENT
BHARAT JYOTI
Lucknow

Lucknow

SECRETARY'S REPORT

NATIONAL SEMINAR ON EXPLORATION OF INDIGENOUS RAW MATERIALS FOR ESSENTIAL OIL INDUSTRY

The seminar, second in series, was held at Central Institute of Medicinal & Aromatic Plants (CIMAP), Lucknow under the joint auspices of National Botanical Research Institute, Lucknow and CIMAP, Lucknow. It was sponsored by Bharat Jyoti Perfumers & Growers Development Foundation, Lucknow and co-sponsored by Council of Scientific & Industrial Research, New Delhi and Council of Science & Technology, U.P., Lucknow. Seminar was largely attended by eminent scientists, traders industrialists, cultivators and experts from various financial institutions. About 150 delegates from all over India representing various research institutions, universities, financial institutions, private institutions, traders, cultivators etc. participated. About 27 papers including 7 invited lectures pertaining to different aspects related to essential oil production were received for presentation. The delebrations were carried on the following sessions:

1. Inaugural
2. Introduction & Survey
3. Cultural Practices
4. Chemistry & Processing technology
5. Marketing, Technology Transfer and Banking
6. Plenary

The seminar was inaugurated by Dr. S.S. Dang, Hon'ble Minister for P.W.D., Government of U.P. on 18th may, 1992. Dr. Dang while stressing the importance of essential oils in day to day life said that the work on the exploration of our indigenous resources will promote not only the production of essential oils in country to meet its internal demand but will also help in earning foreign exchange. This was followed by an informative theme lecture by Dr. R.S. Thakur, Director, CIMAP, Lucknow.

Different sessions were chaired by eminent scientists like Dr. S.K. Jain, Ex-Director, Botanical Survey of India, Calcutta; Dr. S.C.

Datta, Ex-Director, CIMAP, Dr. D.S. Bhakuni, Scientist Emeritus, Central Drug Research Institute, Lucknow and Dr. M.C. Upreti, In-charge, Polytechnology Transfer Centre, Lucknow. Twenty scientific papers, falling in different categories, were presented and discussed. Plenary session was chaired jointly by Dr. R.S. Thakur, Director, CIMAP and Mr. Aijaz Rizvi, Hon'ble Minister of Civil/Supplies & Waqfs, Govt. of U.P. The Chairmen of different sessions submitted their reports and recommendations. The following recommendations were made:

1. Wild plants of Uttranchal, U.P. and other parts of country need proper exploration for essential oil industry.
2. Future planning for cultivation of aromatic plants should be done in consultation with leading perfumery houses so as to have a quantitative inventory.
3. The present definition with regard to cultivation of minor forest products be modified so as to include cultivation of medicinal and aromatic plants.
4. For socio economic uplift of rural and tribal people by providing them self employment through cultivation of some potential aromatic plants on marginal soil should be undertaken.
5. Need to screen the potential aromatic plants available locally and explore the possibility of establishing them in essential oil industry.
6. There is also necessity to develop package of practices for essential oil bearing crops and utilization of alkaline (*Usar*) and waste land for cultivation of aromatic plants.
7. Selection of rain fed crops and development of draught and disease resistant varieties.
8. For increasing land use, efficiency and N economy, intercrops should be identified wherever necessary.
9. Cultivation of nonconventional essential oil bearing crops be emphasised for wasteland development, employment generation and for purpose of value added products while care should be taken not to disturb conventional cropping pattern.
10. Cost effective distillation units should be developed for different categories of farmers and distillers.
11. More chemical and general information is needed to evaluate the possibility for future exploration of aromatic plants. For this there is a need in the country for developing modern

instrumental facilities for essential oils and characteri- of constituents present therein.

12. For the financial assistance from Institutes like NABARD identification of projects should be done by NBRI, Lucknow and CIMAP, Lucknow.
13. More efforts for creating awareness in cultivators & small scale perfumers, involvement of various agricultural universities, Krishi Vigyan Kendras, Bharat Jyoti Perfumers & Growers Development Foundation, Lucknow and various state departments should be taken up.

FUTURE PLAN OF WORK

Future plan of work of Foundation will be on following points:

1. To develop liaison between Scientists, cultivators, producers and users.
2. Screening, examination and evaluation of potential aromatic plants available locally and surrounding area.
3. To bring scientific awakening amongst cultivators, traders and perfumers by holding penal meetings and seminars at various locations and advise cultivators regarding various aromatic crops of industrial interest.
4. Educate people to utilize the marginal soil and other waste land for cultivation of aromatic crops.
5. To develop cost effective distillation unit for small farmers and distillers.
6. To carry the research done in research laboratories to farmers and consumers by inviting various labs/Institutes for process demonstrations.
7. To supply desired information to R & D workers and producers.
8. To collect information regarding essential oil trade in India and abroad for the convenience of traders, industrialists and farmers. Next seminar in the series is intended to be held in 1994. Its theme and topic will be decided later on.

R.K. KHANNA
SECRETARY

THEME LECTURE

It is my great previlage to welcome you all in this Institute on the occasion of the inauguration of the 'National Seminar on Exploration of Indigenous Raw Material for Essential Oil Industry'.

Natural essential oils today form the backbone of indigenous perfumery, cosmetic and flavour industries. It is also a fact that people are becoming more obsessed with anything which is obtained from nature. However, little effort has been made in terms of extension and production activities so as to ensure the availability of raw material for the industry. The holding of present seminar would provide a common platform to the researchers, entrepreneurs, growers and traders to exchange views and to chalk out strategies for all round development of the essential oil industry. There is also a need to create an apex organization which could look after the interest of the cultivators so that they are not exploited by the middlemen/agents. I am hopeful that the deliberation in the present seminar would help us to arrive at some conclusions and recommendations in this regard.

During the last three decades, CIMAP, a National Laboratory under CSIR, has been instrumental in developing agrotechnologies of the essential oil-bearing plants which are already found in the country such as lemongrass, palmarosa, khus, rose etc. It has also introduced exotic essential oil-bearing plants into the country and developed indigenous agrotechnologies for its cultivation. These plants are mints, citronella, lavender, clary sage, geranium, among others.

CIMAP has also developed modern distillation techniques for rose oil comparable to international standard. For distillation of other types of aromatic plants we have developed low-cost, easy to operate, improved version of directly-fired field distillation unit which also gives better recovery of oil. Technologies for value-added products such as menthol from Japanese mint oil, geraniol from palmarosa oil, citral from lemongrass oil, citronellal and hydroxycitronellol from citronella Java oil and linalool and linalyl acetate from *Mentha citrata* oil have also been developed.

CIMAP has also done a good deal of work on improvement of plants employing both traditional and modern techniques and developed certain high yielding varieties which are quite popular among the farmers.

Today, due to efforts of CIMAP, Regional Research Laboratories at Bhubaneswar, Jammu and Jorhat and Medicinal Aromatic wing of ICAR, essential oils worth more than 50 crores of rupees are produced in the country every year, making the country self-sufficient in case of Japanese mint, spearmint and citronella Java oil and saving foreign exchange. This has also generated employment of more than 1 million mandays a year. It may be seen that production of essential oil is a labor intensive venture which could boost the setting up of cottage industries in rural sector and thus providing ample job opportunities to the people.

We have recently geared up our extension programme to meet the increased demand of raw materials for oil industries in the country. We also took the help of Non-Government Voluntary Organization (NGO), Govt. Departments and Progressive farmers and entrepreneurs, wherever necessary in this programme. The present seminar is the second in the series and is the outcome of such efforts by the Institute in collaboration with Bharat Jyoti. First seminar was organised in this Institute from April 11-12, 1990.

We have also organised several training programmes for the farmers and entrepreneurs so as to demonstrate them our latest technologies. We are planning to have such training courses in future also so that more and more people could benefit through our technologies. It may also be pointed out that many of essential oil-bearing plants could also play a significant role in utilization of wastelands in the country. Much effort by the Research Organization and the farmer is required.

In the end, I hope that deliberations of the present seminar would go a long way in the development of essential oil industry not only to cater to the internal demand but also earn sufficient foreign exchange through export.

I wish the seminar all success.

R.S. THAKUR
DIRECTOR
Central Institute of Medicinal &Aromatic Plants
Lucknow

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PROSPECTIVE AND RETROSPECTIVE VIEWS OF AROMATIC HERBS FROM HILLS OF UTTARANCHAL, UTTAR PRADESH

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ABSTRACT

Uttaranchal region comprises eight hill districts of Uttar Pradesh and more than 100 assorted herbs are collected from this region as 'resource herbal commodity' for various industries.

The aromatic herbs, which are collected from this region (temperate and alpine zones) for the purpose of folk condiments are *Angelica glauca* (chora, gandrayan), *Allium stracheyi* (jambu, fern), *Carum carvi* (thoya), *Heracleum canescens* (chattra, chatya), etc.; as folk incense are *Artemisia sacrorum* (kala purcha), *Pleurospermum brunonis* an other species (takkar), *Juniperus recurva* (parpanja), *Rhododendron anthopogon* (atrasu), *Seriphidium brevifolium* (sufed purcha); and herbs used in folk incense as well as marketed as 'resource herbal commodity' in perfumery industry are *Nardostachys jatamansi* (jatamansi), *Selinum wallichianum* and *S. tenuifolium* (bhoot keshi, jatmani no. 2 or nakli jatamansi), *Valeriana jatamansi* (tagar), *Hedychium spicatum* (Kapur Kachri), *Acorus calamus* (bach), etc.

There are also few aromatic herbs which are exclusively collected for the perfumery industry (incense, havan samagri and attar), viz., *Jurinea macrocephala* (guggul, dhup), *Cedrus deodara* (deodar), *Didymocarpus aromaticus* (pathar laung) and *Skimmia laureola* (nair patta, kasturi patta).

There is also wild growing herb *Tagetes minuta,* a source of essential oil but yet not been explored from this region.

There is a strong need to have a quantitative inventory of aromatic taxa used in indigenous and modern perfumery industries for the future planning and cultivation for ensuring a sustained supply.

INTRODUCTION

The eight hill districts, viz., Uttarkashi, Tehri, Pauri, Dehradun, Chamoli, Pithoragarh, Almora and Nainital of U.P. are administratively known as Uttaranchal. Uttaranchal can be divided into three main climatic zones : (i) The Alpine zone, (ii) the temperate zone and (iii) the sub-tropical or sub-temperate valleys. The Terai & Bhabar region of Uttar Pradesh, which is also a part of Uttaranchal has not been included under this study.

(i) The Alpine zone : It consist of two sub zones, (a) the Dry alpine of the interior Himalayan ranges nearing Tibet border at an altitude about 2750 to 4000 m. with low precepitation and xerophytic conditions. It gets snow-fall from November to May and the inhabitants migrate to lower hills during this period. The inhabitants of this region are mostly Bhotias of Niti, Mana, Malari, Burphu, Rail-kot, Kuti, (b) the wet alpine zone that exists from an altitude 2500 to 4000 m. This is further divided into two parts the Alpine forest between 2500 to 3500 m. and above 3500 m. the Alpine meadows. The rainfall in this region is high and therefore, it bears a lush vegetation and Tungnath, Madhyamaheshwar, Gangotri, Vedini fall in this region.

(ii) The Temperate zone : It exists in the outer ranges of Himalayas comencing form 1000 to 2700 m. with moderate rainfall to high rainfall. The towns of Uttarkashi, Pauri, Tehri, Nainital, Almora, Pithoragarh fall in this zone.

(iii) The Sub Tropical or Sub Temperate Valleys : This zone mainly exists in the valleys of the temperate zone. The valleys are warmer and rainfall is moderate and mostly rice is cultivated in these valleys though snow falls in this region but it never stays. The places of this region are Karnprayag, Rudraprayag, Bageshwar, Garur.

Uttaranchal having such varied climatic zones, is rich in vegetation and about 100 assorted herbal plants are collected from

these zones. These herbal plants are either used by the local people as incense, condiments, medicine or for some other purposes or traded for economic gains. The herbs which are traded from Uttaranchal are used variously in different industries such as indigenous pharmacies for manufacturing ayurvedic and unani medicines; indigenous veterinary pharmacies for manufacturing medicines for domestic animals; homeopathic and modern pharmaceuticals for manufacturing homeopathic and modern medicines; indigenous perfumeries for manufacturing attar, incense, havan samagri, tobacco curing; in modern perfumeries and cosmetic industries for extraction of essential oils used in preparation of scents, soap, talcum powders and in flavour industries. The herbal plants therefore are the 'resource commodity' a single herb finds use in various industries.

The aromatic herbs of Uttaranchal are divided into the following categories for the present discussion:

1. The Utilization of Wild Growing Aromatic Herbs

The herbs are used variously as follows :

(a) The herbs exclusively used by the local people as incense, condiments and not traded out of Uttaranchal. These herbs need investigation, exploration and evaluation to be used outside Uttaranchal as incense, condiment, essential oil to be utilized in perfumeries, cosmetics and flavour.

(b) The herbs which are locally used as well as collected for trade purpose and sent to plains in good quantities for economic gains.

(c). The aromatic herbs not used locally but collected and traded for economic gains.

(d) The herbs, which are well known in national and international markets but never been investigated, evaluated and exploited.

2. The Utilization of Locally Cultivated Aromatic Herbs

(e) The aromatic herbs already cultivated or introduced in this region need further investigation, evaluation and exploration of market and finally extension of cultivation if found successful.

3. The Introduction of New Aromatic Herbs and Essential Oil Bearing Horticultural Crops (mostly citrus fruits) in suitable localities and their market exploration.

(f) At suitable climatic locations there are possibilities for introduction of aromatic crops like lavender, clarysage, rose, rosemary, sage and citrus fruits, which apart from their main use as edibles may also be utilised for processing of cordials, squash, marmalade and side by side be used for expression of oil as a by product.

4. The Establishment of Extraction Units for essential oils, oleoresin for wild growing lichens and cultivated ginger crops.

1(a).

Seriphidium brevifolium (Wall.) Y. Ling et Y.R. Ling (*Artemisia brevifolia* Wall ex DC.; *A. maritima* HK.f.non. L.) ASTERACEAE. Sufed purcha (LN).

Plant perennial 0.5–1.5 m. high gregariously growing in dry alpine zone from 2700–3500 m. Locally, the Bhotias collect the immature infloresence and leaves and use it as incense by simply placing the dried material on burning charcoal in a earthen or tin bowl. The analysis of essential oil, Shah & Thakur (1992) from immature infloresence and leaves yielded 0.3-0.4% of oil and the main constituents identified are : α-thujone (77%), β-thujone (4.4%), 1-8 cineole (3.3%) and the mature infloresence and leaves yielded 0.4 to 0.5% of essential oil and the major constituents are; α-thujone (60.2%), β-thujone (5.5%), 1-8 cineole (1.5%). The authors further believe the reason for preferring the use of immature infloresence and leaves could be the high percentage of thujone and 1-8 cinelole. Thujone is a mild intoxicant if inhaled and it is postulated by the authors that the psychoactive property of this incense is beneficial to the Bhotias, who use it as incense to forget the fret and worries due to severe cold conditions and other hardships of the region. There is every possibility to explore the dry infloresence and leaves as incense material for agarbattis and the use of essential oil distilled *in situ* for its use in incense, perfumery, cosmetic and other industries. The material is in abundance and easily collected without any threat to environment.

Artemisia gmelini Web. ex Stechm. (*A. sacrorum* Ladeb ASTERACEAE. Kala purcha, Gangatulsi (LN); Russian wormwood (CN).

Herb is 0.5-0.9 m. high found in dry alpine region from 2300-3000 m. Locally the herb is used as incense and due to its fragrant nature offered to deities. The author collected the sample material from Niti valley and the essential oil was analysed, Anonymous (1983-84 p. 45) Essential oil was 0.3 to 0.5% and the major constituents were d-limonene (45.6%), borneol (11.1%), farnesol (9.2%), thujyl alcohol (9.0%), geranyl acetate (6.9%), α-pinene (6.5%), nerol (3.6%), thujone (2.8%), thujyl acetate (0.9%), cinole (0.2%). The material may further be investigated and evaluated like *Serephidium brevifolium.*

Allium consanguineum Kunth (*A. stracheyi* Baker) LILIACEAE Jambu, faran (LN); Himalayan seasoning Allium (CN).

Scapigerous herb with 30 cm. long narrow leaves occurring in wild state in the dry alpine zone above 3500 m. Locally the dry leaves and infloresence are used as condiment, for seasoning, curries, dal and other cooked dishes. The people of Mana and Niti, cultivate the herb for their own use and for trade purpose. The herb is often found on sale in all the important towns of Uttaranchal. *Allium wallichii* Kunth is also used for seasoning purpose. No report on chemical analysis of the material is available. This commodity needs further evaluation and research as a flavouring agent and efforts should be made to prepare its oleoresin and evaluate it. The flavour of the herb is very appetising.

Pleurospermum brunonis (DC.) C.B. Clarke. ASTERACEAE. Laser or takkar (LN)

Stemless hairy herb with long tapering roots and found over 4000 m. in the wet alpine zone. Its occurrence has become rare due to merciless collection by the local people. Locally it is considered as a prized incense which is offered to deities. No chemical work on its essential oil or the herb is available. The aroma of the herb is very sweet and pleasent and the herb needs protection from the local people.

Rhododendron hypenanthum Balf. f. (*R. anthopogon* D.Don). ERICACEAE. Palu, Kalu-kutti, Poh, Bhallu-sallu, Kodya (LN); Sufer Rhododendron (CN)

Evergreen aromatic herb, 40–60 cm. high occurs gregarious in patches in wet alpine zone at 3000–4000 m. beyond tree line and before the alpine meadows. Locally the decoction of the herb is used for treating asthma and leaves used as incense material. The plant burns even when green therefore much collected by the local people as fuel, Shah & Jain (1988). Leaves are used as one of the ingredient of a non alcoholic beverege known as 'bhotiya chaya' (bhotia tea), specially prepared in a wooden apparatus for mixing known as 'dubong', Bhat & Silas (1989–90). Leaves are crushed and applied on forhead in headache, Paliwal & Badoni (1990). No chemical analysis of the herb or oil is available from Uttaranchal. The commodity needs further investigation and evaluation for its possibilities to be used as incense or the use of essential oil in perfumery, cosmetics and flavour industries.

Artemisia indica Wall (*A. vulgaris* auct no Linn.). ASTERACEAE. Kunjapati, pati (LN).

A fairly tall shrub about 1.0 to 2.5 m. high with gregarious growth distributed throughout the temperate region from 1000–3000 m. Locally, the plant is not used for any purpose except as a offering to deities possibly due to its strong aroma. If a single twig is kept in a room after some time the whole room is scented with its pleasing aroma. Uniyal, Singh, Shah & Naqvi (1985) obtained essential oil from its aerial part 0.2% and the major chemical constituents are camphor (9.7%),; 1-8 cineole (6.5%); β-eudesmol (7.98%); borneol (5.29%), artemisia alcohol (3.4%); camphene (2.59%); p-cymene (1.6%); terpene-4-ol (1.24%) α-pinene (1.2%); α-gurjunene (1.92%). The material is abundantly available and the oil distilled *in situ* could be used in soaps and other cosmetics but further evaluation is required before taking any step.

1.(b).

Juniperus communis L. var. *saxitilis* Pallas. PINACEAE. Bhitaru, parpanja, pama (LN); Juniper (CN).

The shrub is 1.5 m. high and commonly found in the dry alpine zone from 2700–3200 m. Locally the leaves are used as incense. Juniper berry oil is extracted from the fruits and in India the fruits of juniper are imported from Pakistan where the world's biggest forest of juniper exists, which extends in an area of about 100 sq.

miles. It is already found that the oil from leaves of juniper plant equally serve the purpose of juniper berry oil, which is presently imported and the present market rate of the oil is Rs. 1653/- per kg. The material needs further investigation and evaluation and exploring possibilities for its use in 'havan samgri' and evaluation of oil.

Angelica glauca Edgew. APIACEAE. Chora, gandrayan, chipi (LN); Himalayan Angelica (CN)

A herb 1-2 m. high and found in wet alpine zone mostly near ponds and rivulets above 3000 m. Locally used as prized condiment for seasoning purpose also used as medicine in digestive disorders, Shah & Jain (1988). In Himachal Pradesh, the Himalayan *Angelica* has been exploited by few perfumers as a good substitute of European Angelica oil, which is used as toner in masculine note which gives a musky odour and has good demand in the market. In Uttaranchal, the local people have mercilessly depleted the herb, Shah & Mitra (1974). The Bhotias and other people sell the roots @ Rs. 6/- per tola (10 g) for local use as condiment and for seasoning purpose and for medicine in digestive disorders. The exploitation of Himalayan Angelica from Uttaranchal needs to be planned and efforts should be made for its systematic cultivation at suitable localities. The international market rate of European Angelica oil is Rs. 12,600 per kg.

Jurinea dolomiae Boiss (*J. macrocephala* (DC.) Benth.) ASTERACEAE. Dhup, guggul (LN).

A stemless perennial herb found growing in the meadows of wet alpine zone from 3000-4000 m. Locally the root and rhizome of the herb are used as incense and also traded occasionally. From Himachal Pradesh the herb is collected in huge quantities and mostly used in 'havan samagri'. The rhizome and roots on extraction with organic solvents yield a caoutchouc like material. The higher the content of caoutchouc material superior is believed the quality of the herb, Sethi, Atal and Gupta (1964). In Uttaranchal the collection of the herb is tobe conducted in a planned manner otherwise the herb may deplete.

Skimmia anquetillia Tailor & Airy Shaw (*S. laureola* Wall) RUTACEAE. Nair, nairpati, kasturipatta (LN) Himalayan Skimmia (CN).

A shrub 0.5–1.0 m. high found in shady localities in the temperate region or below alpine region from 2000–2500 m. Locally the leaves are used as incense. About two decade ago the Regional Research Laboratory, Jammu had found out the market potential of the oil of *Skimmia* to be used in perfumery as it contains two important perfumery material linalool and linyl acetate. Sharma et al. (1966) found the yield of oil from the leaves 0.5 to 0.8% and chemical constituents-esters of linyl acetate (71.5%); linalool (17.5%); β-phellandrene (12.7%) and 8 other minor constituents. About ten years ago few enterprising entrepreneurs of Uttarkashi installed a distillation unit for extraction of oil and the herb was collected from nearby forest but after some time the forest authorities imposed ban on collection of the herb with the argument that the leaves of skimmia are the main food of musk-deer. Mr. Green, a scientist working at Dept. of Biology, University of Cambridge, U.K. made detailed study about food of the muskdeer and found out that *Skimmia* is not a staple food of muskdeer and mostly it feeds on *Rhododendron* species, Shah (1988). *Skimmia* oil is used in high grade perfumeries and it has good demand in the perfumery industries. The plant can be propagated by stem cutting and the U.P. Forest authorities should allow the collection of Skimmia in a planned way.

Valeriana jatamansi Jones (*V. wallichii DC.*) VALERIANACEAE. Sumeo, sumea (LN); tagar, sugandhbala (TN); Indian Valeian (CN).

A perennial herb 15-65 cm. high found throughout the temperate region from 1800-2500 m. in shady and moist localities mostly in oak and rhododendron forest. Locally the whole vegetative herb used as incense and mature herb rhizome is collected for trade purpose. The rhizomes of Indian valerian are in good demand as these are used in various industries. It is used in indigenous pharmaceutical industries for manufacturing number of proprietary medicine of ayurveda, unani, sidha and tibetan system of medicine; in the perfumery industries for manufacturing attar and extraction of essential oil; used in tobacco industries in the process of curing; and recently it had found its use in the modern medicine as a number of epoxy-iridoid esters collectively known as valepotrates discovered in 1966 used to improve coordination, diminishes restlessness, anxiety and aggressiveness in young students and increases the

power of concentration. The herb needs immediate protection in nature as it has been collected in huge quantities from the wild and it needs systematic cultivation at suitable locations. The present market rates of the oil of valerian is about 6500/- per kg.

Selinum candolleii DC. APIACEAE. Moor, bhutkeshi (LN) Nard selinum (CN) Nakli jatamasi (TN)

A perennial herb 25-50 cm. high found in temperate forest at 1800-2100 m. Locally the rhizomes are used in magicoreligious ceremonies mostly to dirve away the evil spirits. The rhizomes look like jatamansi. The rhizome of *S. vaginatum* (Edgew) C.B. Clarke are also used as 'bhutkeshi'.

1(c).

Cedrus deodara (Roxb.) Loud. PINACEAE. Deodar, diyar (LN); Cedrus (CN)

A high tree found above 2000 m. in the temperate zone. Earlier when the trees were cut freely, the saw dust available on distillation yielded cedarwood oil and the saw dust was also used as an ingredient in 'havan samagri'. But now there is a complete ban on cutting of trees in the hills and therefore saw dust is not available from the saw mills. But there is a good demand of the cedrus oil in the perfumery industries. Aggarwal et al. (1973) had found out the root of old cut trees stumps can yield under optimum condition 8-12% of essential oil in comparision to 2.6-4.5% usually obtained from the saw dust and chips. Uttaranchal can also be a good source of the old dead trees stumps available commonly in the cedrus forests. The forest department of U.P. should allow the young entrepreneurs to dig out the old stumps of dead trees and side by side replace the pit with new seedlings of cedrus plants, which would grow into a tree in due course of time.

Cinnamomum tamala Nees & Eberm. LAURACEAE. Kikar (LN) Taj, tejpat (TN)

A medium size tree found in between 2000-2500 m. in shady forest in the temperate zone. The leaves and bark of the trees are under the trade name 'taj' and 'tejpat' respectively and marketed to the plains where these are used in various industries like indigenous pharmacies, condiment manufacturers and dealers. The essential

oil from the leaves of *C. tamala* have been analysed by Gulati (1982) with the following main constituents, the yield of oil is 0.23-0.36%; cinnamaldehyde (41-55%), linalool (15-15.67%), eugenol + cinnamin acetate (4.23-13.3%), caryophylline (4-7.26%), eugenyl acetate (0.06-12.45%), benzaldehyde (2.0-4.11%), camphor (0.9-3.19%), β phellandrene (0.10-3.95%). It is interesting to note that the essential oil obtained from the leaves of *C. tamala* of Assam does not contain eugenol. In recent years the plant of *C. tamala* from Uttaranchal have been mercilessly lopped and debarked due to which a number of trees have died. It is needed that necessary steps may soon be taken for their systematic and scientific collection so that the tree is not harmed and destroyed and efforts should be made for its systematic cultivation and regeneration in the forest. Presently, only leaf and bark are marketed but no efforts have been made to distill cinnamomum oil for commercial purpose from the leaves in Uttaranchal. During 1987-88 cinnamon leaf oil worth 4.6 laks rupees was imported from Sri Lanka and Indonesia. Cinnamomum oil has good market within the country.

Zanthoxylum armatum DC. (*Z. alatum* Roxb.) RUTACEAE. Timur, timru (LN) tejbal (TN) Wartara (CN)

A spiny shrub with 1-2 m. hight found in the temperate region from 1300-2500 m. Occasionally the aerial shoots are used as tooth-brush like 'neem'. The fruits are collected for trade purpose as these are used in indigenous pharmacies and indigenous perfumery industries. Sharma et al. (1966), Adhikari et al. (1985-87) have reported the oil yield from the fruit 0.4-0.5%. The author in an experiment collected fruits from Uttaranchal and the pericarp of the fruit were removed and subjected to distilation. The yield of oil was found 10-12% and on analysis the following main constituents were identified, linalool (72%), methyl cinnamate (12.20%), limonene (6.2%), β phellanderene (5.3%) and 25 other minor constituents, Shah (1991 b). Tejbal could be a good source of linalool which has good demand in the perfumery and cosmetic industries. During 1990 and 1991, 20 tonnes and 70 tonnes of natural linalool were exported respectively and 30 to 70 tonnes were produced in the country (possibly from *Bursera delpechiana*, (linaloe) cultivated in S. India), Varshney (1989). The oil needs further research and investigation and evaluation as in USA the oil of allied species of *Zanthoxylum* are used in inscecticidal sprays.

Hedychium spicatum Smith ZINGIBERACEAE. Vanhaldi, siaru (LN); Kapurkachri (TN)

A herb 0.5-1.5 m. high and found mostly in shady and moist forests in the temperate zone. The rhizome of the plants are collected by the local people for trade purpose. The rhizomes are mostly used indigenous perfumery industries for preparation of attar and in indigenous pharmacies. Recently few oil distillers have broutht its oil in the market from Himachal Pradesh. The herb now needs planned collection from the wilds and systematic cultivation at suitable localities as the rhizome in the market is sold @ Rs. 25-30 per kg. and the oil yield is 0.4%.

Acorus calamus L. ARACEAE. Bach, boja (LN) ghurbach (TN) Sweet flag (CN)

A herb 0.3 to 1.0 m. high and usually found in marshy and damp localities in the temperate region near lakes, ponds and rivulets. Occasionally the rhizomes are used to cure cough, cold and asthma but mostly traded for economic gains. The rhizomes are used in the indigenous pharmacies and perfumeries and in Veterinary medicine mostly in preparation of flea powder. The essential oil contains asarone 80-84% and which has been reported to be cancerous therefore not used for flavouring purpose in India. The North American A. *calamus*, a chemical strain does not contain asarone therefore much used for flavouring food and liquors. Research is needed either to make the oil free from asarone or to develop a strain free from asarone. Essential oil of A. calamus is being produced from Himachal Pradesh and being marketed. In recent years the rhizomes of *A. calamus* have been mercilessly collected from the hills of Uttaranchal and now it needs cultivation and suitable places would be the temperate valleys near rice fields on the river banks.

Didymocarpus aromatica Wall. and *D. pedicillata* R.Br. GESNERIACEAE. Patharchatta, patharphori (LN), patharlaung, kumkum (TN)

A stemless herb found clinging on rocks round in shady and moist localities in the temperate zone from 1000-1500 m. Earlier the curled young leaves were collected from this region and traded to be used in indigenous perfumery in preparation of high grade attar. Now it is seldom collected because it was mercilessly collected by

the local people. It is recommended that a complete ban on its collection may be imposed by the government.

1(d).

Hyssopus officinalis L. LABIATEAE. Zufa, zufeyabis (TN) Hyssop (CN)

Herb is about 1.0 m. high and found in gregarious patches in dry alpine region at an altitude of 2300-2500 m. Local use is none but in Unani system of medicine the herb is referred as 'zufa' or 'zufeyabis' but presently in India under this name some other herb is available. It is reported that earlier the herb was cultivated in Germany, France, USSR and USA as potherb, Guenther (1961), Bianchini (1977) and Lawrence (1984). The present position of the herb cultivation in these countries is not available. The author collected the herb from Malari (Chamoli) which yielded 0.4 to 0.5% of oil characterised by 47 chemical constituents. The major components are isophenocamphone (38.1%), pinocarvone (20.3%), 1-8 cineole (12.2%), β-pinene (10.2%) and pinocamphone (0.51%), Shah (1991 a). On comparison with the oil cultivated in North America and with hyssop growing wild in Himachal Pradesh, it was found that the essential oil from Uttaranchal region is characterised by lesser quantity of pinocamphone, i.e., 0.51%, while the cultivated one from North America and the wild from Himachal Pradesh is characterised by 42.66% and 38.44% respectively. The lower quantity of pinocamphone may be useful so that the oil could be used for flavouring purpose as it is reported that higher quantity of pinocamphone in the oil causes cancer therefore the use of oil for flavouring purpose is banned in U.S.A. The essential oil of hyssop and the hyssop-herb from Uttaranchal needs proper evaluation and its market exploration.

Area	Yield of Essential Oil %	Thymol	P-cynene	borneol
Kulu (HP)	0.5%	64.6%	9.1%	5.6%
Manasbal (J & K)	0.5%	59.3%	13.4%	7.9%
Chakrata (UP)	0.4%	19.1%	46.9%	3.9%

Origanum vulgare L. LABIATEAE. Vantulsi (LN) Wild marjoram or oregano or pizza (CN and TN)

An annual herb 30-60 cm. with white orange flowers found in moist and shady localities from 2000-3000 m. in the temperate and alpine zones. Locally, the herb is used as an offering at Badrinath temple and sometime the decoction is taken in cough and cold, Shah (1987). There are two main types of oregano, the carvacrol type and thymol type. The carvacrol type is considered as good oregano, which contains about 70% of phenyl carvacrol. The herb was collected by the author from Joshimath region and on analysis yielded essential oil 0.6% characterised with the following main constituents; thymol (71.3%), α-terpinene (12.7%), α-pinene (10.10%), camphor (3.2%), p-cymene (0.5%), carvacrol (0.7%) Anonymous (1983-84, p. 45). Oregano is well known culinary herb in trade as its dried herb, tincture and essential oil are used in flavour industry and certain liquor formulations. U.S.A., Italy, France and Germany are some of the countries, which consume oregano in huge quantities. The main suppliers are Maxico and some of the European countries like Greece, Turkey, Spain, Egypt. Though, the oregano of Uttaranchal is the thymol type and it may have its use in flavour and other industries, however it needs further investigation, evaluation and exploration of market. Presently, the Spanish oregano oil is sold @ Rs. 1026/- per kg.

Thymus linearis Benth. (*T. serophyllun* L. ssp. *quinquestatus* (Celak) kitamura LABIATEAE. Bana jewain (LN) Himalayan Thyme (CN)

A common prostrate herb found in wet temperate and wet alpine zone from 1500-4000 m. Locally the herb is used in cough and cold, Shah & Jain (1988). Chemical analysis of Himalayan thyme from Kashmir, Himachal Pradesh and Uttar Pradesh hills (Ut-

borneo acetate	Linalool	Carvacrol	α-terpenene	nerilodol
5.4%	3.1%	5.0%	3.6%	2.5%
1.3%	7.4%	1.9%	4.7%	1.8%
1.9%	5.7%	2.5%	5.0%	5.6%

taranchal), are reported by Anonymous (1982-83 p. 45) which is given in the table. Himalayan thyme has great resemblence with *Thymus vulgaris* the true Thyme, which is an important culinary herb much used in meat and savoury dishes with good market in European countries and the thymol content varies from 20 to 60 % and true Thyme oil is sold @ Rs. 1080 per kg. Himalayan Thyme of Uttaranchal requires detailed investigation of the herb and its essential oil from different altitudinal regions and evaluation of the herb and oil in the trade market. Owing to the increasing availability of synthetic thymol the demand of thyme oil has considerably decreased but still there is preference to natural oil then synthetic thymol. Most of the botanical and chemical investigation undertaken on this plant have referred the plant as *Thymus vulgaris*, while *T. vulgaris* is not found in India, and whatever work is reported is on *T. linearis* and its subspecies.

Tagetes minuta (*T. glandulifera*) COMPOSITAE (ASTERACEAE). Van hazari (LN) Wild marigold (CN)

An annual herb 1–1.5 m. high found in the temperate region of Uttaranchal. The plant is native to Mexico and probably introduced about a century ago in the country. Locally, the juice of the flowers is dropped in aching ear, Shah & Jain (1989). The herb of Uttaranchal yielded 2.0% of oil, Shah (1987) but no chemical analysis is available from Uttaranchal, however, the oil from African wild marigold has been characterised with the following main constituents; ZB ocimine (41%), dehydrotagetone(13.5%), Z & E ocimenone (26.5%), De Villers et. al. (1971). One of the perfumer from Himachal Pradesh in Kulu has distilled the oil from the wild growing marigold and produced essential oil for market sale. The essential oil of *Tagetes* needs further exploration of market for its ready sale. It is required that the essential oil samples may be brought to the notices of leading perfumers of the country for evaluation purpose. There will be no difficulty in the availability of the material from Uttaranchal as it it found growing in waste lands abundantly and distillation of oil *in situ* would be profitable.

Carum carvi L. UMBELLIFERAE (APIACEAE). Thoya, Kala jira, tibbati zeera (LN); Himalayan caraway (CN)

A perennial herb 20-60 cm. high found above 3500 m. in the dry alpine zone. The people of Niti, Mana and Milam collect it from

the wild and cultivate it in their kitchen garden or waste fields for their own use. Locally, the fruit is used as main condiment and for seasoning purpose. The seeds collected by the author from Niti valley yielded essential oil 4.1% and the main constituents characterised are; carvone (64.05%), limonene (30.04%), dehydro carvone (1.35%), eugenol methyl ether (0.47%), Anonymous (1983-84 p.44). In caraway fruits the quantity of carvone plays an important part in making its quality, more the carvone contents better is the quality. The caraway oil contains 53-59 % of carvone, Anonymous (1978). Lawrence (1980) made a detailed analysis of caraway oil and found that main constituents are; carvone (47%), limonene (49.8%) with other minor constituents. Therefore, the fruits of caraway of Uttaranchal has wider prospects for application in flavouring pharmaceutical products, toothpaste, mouth washes and for flavouring beverages. The only thing is required is the exploration of the market for ready supply and when market is assured then encourage the local people of border region to cultivate it in big way.

Saussurea costus (Falc.) Lipsch (*S.lappa* (Decne) Sch. Bip.) COMPOSITAE (ASTERACEAE). Kuth (LN) Kostus (CN and TN)

Plant is 1.5 m. high with big triangular leaves. The plant is reported to be cultivated occasionally in Milan, Mana, Laspa, Railkot, Burohu for the roots which are locally used for curing asthma, gastric disorders etc., Shah (1987). Kuth plant originally belongs to Kashmir and it was the Kashmir State monopoly in Kuth trade. From Kashmir it was brought to Himachal Pradesh by the missionary people, who cultivated the plant for economic gains as there was a great market of Kuth in China. In 1929. kuth was introduced in Bhuna nursery (Chamoli) and cultivated on commercial scale by the Forest Department to be exported to China. But after the IInd world war the trade was abondoned and the Bhuna nursery was converted into an experimental medicinal plants nursery by the forest department Shah & Yadava (1970). The author visited twice the nursery in 1967 and another time in 1985 and found that the nursery is an abandoned nursery but there are more than 5000 Kuth plants left uncared. It is well established from the earlier experiments that the plant can be easily cultivated in a cool & humid localities above 2500 m. in the wet alpine zone, where monsoon rains are not much. The essential oil of kuth has good demand in high class perfumery mostly in France and therefore there was a proposal

to establish a Rs. 5 crore plant unit in Himachal Pradesh in collaboration with the French government for processing of kuth roots and separating its important constituents. Kuth was earlier cultivated in Kulu district by the Kuth cooperative Society. The present position of the proposed project and the cultivation of kuth is not known from Himachal Pradesh. If there comes any big scale demand of the kuth then the cultivation of the plant can easily be taken in Uttaranchal and distillation of oil and oleoresin extraction units can easily be established *in situ.*

Perilla frutescens (L.) Britt (*P. ocimoides* L.) LABIATEAE. Bhangira, Bhang jira (LN); Selum (Nepal & Sikkim), Common perilla (CN)

Plant is 0.5-1.2 m. high and mostly cultivated in the temperate region from 1500 to 2000 m. for the seeds, which are locally used as condiment for flavouring purpose. Common perilla is among the oldest food and condiment crop cultivated throughout the East Asian countries and mostly in Japan. The aerial parts of the plant after seeds harvest were collected by the author from Uttaranchal and subjected for analysis by Anonymous (1983-84 p. 44) the oil by hydrodistillation of the aerial part is 0.6 % and the main constituents reported are; carvone (57.08%), carvyl acetate (32.72%) methyl chavicol (2.8%) and linalool (1.5%). This was an preliminary analysis. Mishra & Hussain (1987) in an experiment raised the crop at CIMAP, Lucknow from the seeds collected from Bangladesh and hydrodistilled the inflorescence that yielded 0.15% of essential oil with main constituents as rosefuran (58%), β-caryophylline (15.9%) and perilla ketone (8.00%). Due to presence of rosefuran an important constituent of rose oil, the authors propose the use of the Common perilla oil for blending of the oil for rose odour. In Japan, the perillartine, a monoterpine extracted from the essential oil (not mentioned either from the plant, inflorescence or the seeds) is used to sweeten and flavouring tobaccos, Lewis & Lewis (1977). It is further needed that the aerial parts from which the seeds have been harvested may again be subjected for further analysis of essential oil and its constituents may again be characterised and the oil may be evaluated. Investigation of the seeds of Common perilla also need further investigation and evaluation.

3(f) Introduction Of Essential Oil Bearing Crops

There are possibilities for introduction of essential oil bearing crops like lavender, clarysage, rose and the horticultural citrus fruits in Uttaranchal.

Aromatic Herbs

Theoretically, the inner valleys of dry alpine zone like Niti has been identified climatically suitable for cultivation of crops like lavender, clarysage and rose, Shah (1989).

Lavendula angustifolia P. Miller subsp *angustifolia* LABIATEAE. Lavender (CN & TN)

The aerial part on hydrodistillation yields oil of lavender and this crop was introduced for commercial cultivation by CIMAP Tajuddin et al. (1988) though it was long been introduced in the country for experimental purpose by RRL Jammu in Kashmir. The oil is used in high grade perfumery, colognes, lotions. The present production of the oil in the world is about 1000 tons per annum and the main producers are Bulgaria, USSR and Tasmania. India imports oil of lavender worth 52.3 laks of rupees and the present Indian market rates are Rs. 600/-per kg.

Salvia sclares L. LABIATEAE Clarysage, Sage oil

The inflorescence part of the plant on hydrodistillation yields clarysage oil, which is mostly used in perfumery as well as in flavour industries for flavouring liquors and confectionaries, The aroma of the oil blends easily with other oil aroma. The present production of the oil in the world is more than 100 tons per annum and the main countries to produce the oil was USSR and Bulgaria and the persent international market rate for the oil is Rs. 3000/-per kg.

Rosa damascena Mill. ROSACEAE, Desigulab, Bulgarian rose (CN)

The petals on hydrodistillation yield rose oil. The rose oil has good demand in the perfumery and flavouring industries including the pharmaceutical. Present production of rose oil in the world is 15-20 tons per annum and the main producer is Bulgaria and the international market rate is Rs. 1.34 lac per kg. and in Indian market the rate is Rs. 1.0 lac per kg.

Rosemarinus officinalis L. LABIATEAE Rosemary (CN)

Rosemary is mostly used as berb in cooked dishes because of its antioxidant properties and also used in the manufacture of meat based products. The essential oil from the leaves is an important ingredient in cosmetics, perfumes and insect repellent. The world production is about 970-1020 tons per annum and the main producer is mediterranean basin Mafeti (1992). Though, the crop had been experimentally grown in Kashmir but large scale oultivation has yet not been tried.

Salvia officinalis L. LABIATEAE Sage, sage oil (CN)

The dried herb as well as essential oil are used in home cooking commercial meat processing, etc. It is used in herbal teas in Europe. Its essential oil is used to flavour liquor, bitters, in condiments and cured meats and as an ingredient in perfumery formulations, Mafeti (1992). Oleoresin of sage is also prepared, which is used as flavouring agent in industrial meat processing. Annual production of sage oil is 1750 tons per annum and international market rate of the oil is Rs. 800/-per kg. The main producing countries are Albania, Greece and Turkey. What is needed is to cultivate the above stated crops experimentally at suitable localities extract their essential oils and herb and get it evaluated by the foreign buyers and when assured of marketing then large scale cultivation may be undertaken.

Expressed Essential Oils

The hills of Uttaranchal are found very suitable for cultivation of citrus and orange fruits and already a number of species are being cultivated, which are mostly sold as fruits and not processed for squash, cordial, marmalade. If suitable varieties and species are introduced in the hills mostly for processing purpose then as a by product cold expressed essential oil may be obtained.

Citrus sinensis CITRACEAE Orange sweet oil

The peels of *Citrus sinensis* on cold expression yield, the orange sweet oil, which is mostly used for flavouring soft drinks baked goods and confectionaries and in soaps and other cleansing products and aerosols. It is also a source of d-limonene an important flavouring compound, which has good demand in the market. The total world production of range sweet oil is about 15000 tons per annum but demand is estimated to be 2000-2500 tons per annum. India imports

orange sweet oil worth Rs. 54.16 laks. The other byproduct obtained from it could be pectins, animal feeds.

Citrus limon (Linn.) Burm. f. CITRACEAE Pahari nimbu (LN) Lemon (CN)

Cold expressed lemon peels yield lemon oil, which has also good demand within the country as it is used in soft drinks, confectionery and pharmaceutical products. The world production is about 2000-2500 tons per annum.

To establish these two above stated industries in the Uttaranchal hills it is required that a horticultural survey for the citrus and orange growing regions should be made, where these are being cultivated in considerable quantities and the regions where citrus crops can do well. The Horticultural Department of U.P. Hills wold be the most appropriate agency who could supply this information as the department has already established canning and processing fruit industries in some of the localities for processing squash and cordial, A leading fruit processing company is already collecting lemons oranges, malta, etc. from Mandal (Chamoli) and transporting these to plains for processing squash, marmalade, etc. Information is not available whether this company is using the fruit peels for expression of oil or not. Present market rate of lime oil is about Rs. 400/-per kg. and India imports lemon oil and other citrus fruit oils worth about Rs. 70 lacs per annum.

4. Establishment Of Grading & Processing Units

Lichens (*Parmelia* sp., *Usnea* sp., *Ramalina* sp.) Jhoola, charila, (LN) (TN), Stone flower, Oakmoss (CN & TN)

Different species of lichens are mostly found in oak, rhododendron and pine forests in Uttaranchal. These lichens are commercially traded in huge quantities from this region, which are used in indigenous perfumery (attar industry), modern perfumery (oleoresin used in cologne, soaps and fragrances), incense industry (havan Samigri), in flavour industries (in sambhar and garam masala and in tobacco Curing) and in indigenous systems of medicine in ayurveda under the name 'shailya' and in unani under the name ushna. In the year 1983-84 about 7500 quintals of lichen was traded from Uttaranchal Shah (1987) mostly to Kanpur, Lucknow and Nagpur. It is estimated that about 100 m. tons of lichen of

high grade is exported from India to produce concrete, absolute and resinoids. The main regions in the country from where lichens are collected are Assam, Nepal, Uttaranchal and Himachal Pradesh. Presently, lichens which are collected from Uttaranchal are transported to plains at railheads like Kotdwar, Ramnagar, Kathgodam and tanakpur, where these are graded to cater the needs of above stated industries. Mostly these are graded in to three grades as detailed below:

Grade 'one'–It consists of *Parmelia nilgherrensis* Nyl. exclusively.

Grade 'two'–It consist of *P. nilgherrensis, P. nepalensis* Taylor and *P. cirrhata* Fr. about 90-95% mixed with *Usnea susordida* Triton, *Ramalinainflata* (J.D. Hook & Taylor) J. D. Hook & Taylor and *R. subcomplanata* Auct about 5-10%. This grade is used mostly in indigenous perfumery.

Grade 'three'–It consist of *Parmelia* spp. of grade IInd about 60-75% mixed with *Usnea* and *Ramalina* spp. about 20-25% . This grade is mostly used in flavour industry as an ingredient of 'garam masala' and 'sambhar masala' and in indigenous pharmaceutical industries.

Grade 'fourth'–In this grade the *Parmelia* spp. are about 20-25% and *Usnea* and *Parmelia* sp. about 70-80%. This grade is mostly consumed by the indigenous tobacco curing industry and in 'havan samigri.

Presently, all grades of lichens are collected from Uttaranchal but not graded *in situ*. It is required that the grading should be done *in situ* and possibilities for establishing extraction units for oleoresin may be explored.

Zingiber officinalis Rose. ZINGIBERACEAE. Adrak (CN & TN) Ginger (CN)

It is a well known agricultural crop and is cultivated near Chakrata (Dehradun) in a big way. There is possibility to establish a ginger oil and ginger oleoresin extraction unit nearby Chakrata hills. Ginger oil is largely used as flavouring material in alcoholic and non alcoholic beverages. The oleoresin is used in confectionery and perfumes. Present market rate of the oil is about Rs. 900/- per kg.

CONCLUSION

It is concluded that the aromatic herbs of Uttaranchal need the following action for establishing the essential oil industry and for their conservation and preservation.

The locally growing species like Himalayan angelica, Skimmia, Indian valerian, Hedychium, Cinnamomum, which have been much exploited in recent years need systematic and planned collection and regeneration in the forest or in the farmrs' fields.

The locally growing herbs like Sweet flag, Caraway, Costus which have good market demand should be encouraged for cultivation in farmers fields at suitable localities.

Proper markets may be explored for the essential oils which could be easily obtained from Zanthoxylum, Hyssopus, Juniper and wild marigold. Side by side the forest authorities may be approached to allow the collection of stump of cut deodar trees and the Skimmia leaves. There is need for establishement of field units at suitable localities, for the extraction of cold expressed essential oils from lemons and orange peels as a byproduct, and oleoresin from lichens and essential oil and oleoresin from ginger.

It is suggested that some leading perfumers should come forward and act as entrepreneurs and install hydrodistillation units for essential oils and extraction units for oleoresin *in situ* and encourage the cultivation of the aromatic crops.

The aromatic species which are commonly available like *Serephidium brevifolium, Artemisia gmelinii, Rhododendron anthopogon, Origanum vulgare, Thymus lineraris, Perilla frutescens* either need detailed analysis of essential oils or evaluation in the international market or Indian markets or Chemical analysis and evaluation both.

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AVAILABILITY OF LAND FOR CULTIVATION OF AROMATIC PLANTS

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ABSTRACT

The source of raw material for essential oil industry has been mainly those plants which have been exploited indiscriminately to meet the ever rising demand of the industry. As a result, such plants are becoming scarce and many species have already become endangered. The urgent measure needed is to carry out large-scale cultivation.

Essential oil Industry requires continuous supply of raw material, which is possible only when there is a continuous cultivation programme matching with industrial requirement. Each species has its own edaphic and climatic limitation. Similarly, every piece of land has its own property in terms of NPK, mineral salts, organic matter, moisture and pH values. A good combination between these two will result in best out put in terms of cost benefit analysis. The priority, on marginal lands being agriculture, eliminates the possibility of its diversion for growing aromatic plants.

The availability of forest land is limited. In addition to civil and soyam land under the control of Revenue Deptt., there is vast stretch of wasteland lying fallow. The gap between the demand and supply linked with profitability opens up an avenue for participation of absentee and surplus land lords as well. A convincing viable project and its wide publicity is needed.

INTRODUCTION

The source of raw material for Essential Oil Industry has been mainly plants occurring naturally. These plants have been exploited on an unrestricted scale to meet the ever rising demands of the industry. As a result such plants are becoming scarce and many species have already become endangered and many more may fall into this category in not too distant a date if the present pace of exploitation continues unabated. Thus urgent measures are needed to rectify the present state by taking special steps to carry out large scale cultivation.

AVAILABILITY OF LAND

Like any other industry the Essential Oil Industry also requires continuous supply of raw material, the aromatic plants. This is possible only when there is continuous cultivation programme matching with industrial requirement. All plants possess its own edapho-climatic limitation. Similarly every piece of land has its own physico-chemical properties in terms of N, P, K and other Mineral Salts, Organic Matter, Moisture and pH Value. A good combination between the two only will result in best possible out-put in terms of cost benefit analysis. When one looks for land, forest receives the first attention followed by waste land. The priority, on marginal lands being agriculture, eliminates the possibility of its diversion for growing aromatic plants.

THE FOREST [CONSERVATION] ACT, 1980

[1] This act is applicable since 25.10.1980 throughout the country except the State of Jammu & Kashmir. Relevant portions of the act and the guidelines issued thereunder are quoted below:

[a] According to clause 2 (a) (ii) of the act any forest land or any portion thereof may be used for any **non-forest purpose** only with the prior approval of the Central Government.

[b] Applicability of this act has been defined by the Central Government in their circular dated 23.06.1989. According to the circular "The term **Forest Land** mentioned in Section 2 of the act refers to reserved forest, protected forests or any area recorded as forest in the government records. Lands which are notified under Section 4 of the Indian Forest Act would also come within the purview of the Forest

[Conservation] Act, 1980 [Supreme Court's judgement in NTPC's case]. All proposals for diversion of such areas to any non-forest purpose, even if the area is privately owned, would require the prior approval of the Central Government under the Forest [Conservation] Act, 1980".

As the civil and Soyam Forest of Uttaranchal were earlier declared as Protected forest are also subject to the provisions of this act.

[c] clause 2 (a) (iii) of the forest [Conservation] Amendment act, 1988 **prohibits** the sanction of lease without prior approval of the Central Government.

"(iii) that any forest land or any portion thereof may be assigned by way of lease or otherwise to any private person or to any authority, corporation, agency or any other organisation not owned, managed or controlled by Government".

[d] The guidelines of the central Government issued on 24.10.1989 explains in detail the provisions of sub-clause 2 (a) (iii) as under :

[i] the sub-clause shall not be attracted when any forest land or any portion thereof is assigned to any authority, corporation, agency or any other organisation wholly owned, managed or controlled by the concerned State/Union Territory Government and/or the Central Government. Such Government owned, managed or controlled authority/ corporation/agency, which has been assigned such forest land shall not reassign it or reassign a part thereof to any organisation or individual.

[ii] Any lease or agreement or order for carrying out forestry operations or disposal (including sale) of forest produce shall not attract the provisions of this sub-clause so long as this is limited to collection and/or appropriation of such forest produce and provided it does not cause or is likely to lead to any change in the prevailing land use practices in the forest area in question.

[iii] The sub-clause shall be attracted in case the forest land is assigned to a joint sector company under partnership with State/Union Territory Government/Central Government and/or any organisation there under.

[iv] Any scheme or project which involves assignment of any forest land or portion thereof by way of lease or similar arrangement, for any purpose whatsoever, including afforestation to any private persons or to any authority/agency/organisation not wholly owned managed or controlled by the concerned State/Union Territory Government and/or the Central Government shall attract the provisions of this sub-clause.

[e] The term **non-forest purpose** has also been explained in the above ammendment as under :

"Explanation - For the purpose of this section **non-forest purpose** means the breaking up or clearing of any forest land or portion thereof for -

[a] the cultivation of tea, coffee, spices, rubber, palms, **oil-bearing plants,** horticultural crops or **medicinal plants**;

[b] any purpose other than reafforestation, but does not include any work relating or ancillary to conservation development and management of forests and wild life namely, the establishment of check-posts, fire lines wireless communications and construction of fencing bridges and culverts, dams, waterholes, trench marks boundary marks, pipelines or other like purposes".

[2] The availability of forest land for the purpose of cultivation of Aromatic plants is therefore subject to prior approval of the Central Government. For this detailed guidelines have been issued both by the Central Government as well as by the State Government. As this process takes some time therefore, **advance planning** is necessary. One of the important requirements of this procedure is the Compensatory Afforestation at the cost of the project. The relevant provisions as of today are reproduced below.

The following norms are laid down for compensatory afforestation :

[i] Where non-forest land are available, compensatory afforestation be raised over equivalent area of non-forest land.

[ii] Where non-forest lands are not available, compensatory plantations be raised over degraded forests twice in extent to the area being diverted.

[iii] Where non-forest land available is less in extent to the forest land being diverted, in addition to the compensatory afforestation on available non-forest land plantation be raised in degraded forest twice in extent to the difference between forest land being diverted and available non-forest land.

It should however, be made clear that non-availability of non-forest lands for compensatory afforestation would be accepted by the Government of India only on a certificate to that effect from the Chief Secretary to the State/Union Territory Government.

[iv] In hill districts as per list which will be separately circulated, and in other districts having forest land exceeding 50 percent of the total geographical area, compensatory afforestation on non-forest land will not be insisted upon and it may be allowed on degraded forest land twice in extent of the area diverted provided forest land involved is less than 5 hectares and the purpose of diversion is any of the following : construction of link roads, small water works, minor irrigation works, school building, dispensary, hospital, tiny rural industrial shed of the Government or any other similar work which directly benefit the people of the area.

[v] In respect of proposals where diversion of forest land is less than 1 hectare, 10 trees shall be planted for every tree felled. However, the minimum number of trees to be so planted shall be computed at the rate of 2500 trees per hectare for the forest area being actually diverted. Even in cases where no tree felling is involved, planting of trees at the rate of 2500 trees per hactare of the forest area involved will have to be done.

STRATEGY

With the constraints on availability of land for cultivation of aromatic plants there is urgent need to identify the plant species which requires to be cultivated on priority basis. Thus, annual requirement in terms of output for the industry as a whole will determine the backward linkage in terms of land requirement for cultivation. In view of the suitability of land due consideration may be given for the following sources though on commercial basis.

[i] The absentee and surplus landlords may be persuaded to make use of their such land, either by themselves or in cooperation with the promoters/industry for cultivation of such essential oil bearing plants. This requires convincing viable projects.

[ii] Fallow land available may be explored for such purposes. This type of land requires heavy investment for improvement.

[iii] Cultivation of medicinal and aromatic plants was earlier a part of forestry activity. This programme needs to be revived on commercial scale under the guidance of experts for supply of raw material to the industry in mind.

[iv] Herbal research and development institute, Uttaranchal should establish, through Forest Department, demonstration farms to educate and create awareness among the cultivators of economically viable plants.

[v] Use of forest land for this purpose requires prior approval of the Central Government. With the constraints of compensatory afforestation under the act, the demand for forest land should be restricted to an area less than 5 hectares in extent in the hills or as amended subsequently.

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STRUCTURE AND PROCESS OF SECRETION OF ESSENTIAL OIL PRODUCING GLANDS IN PLANTS

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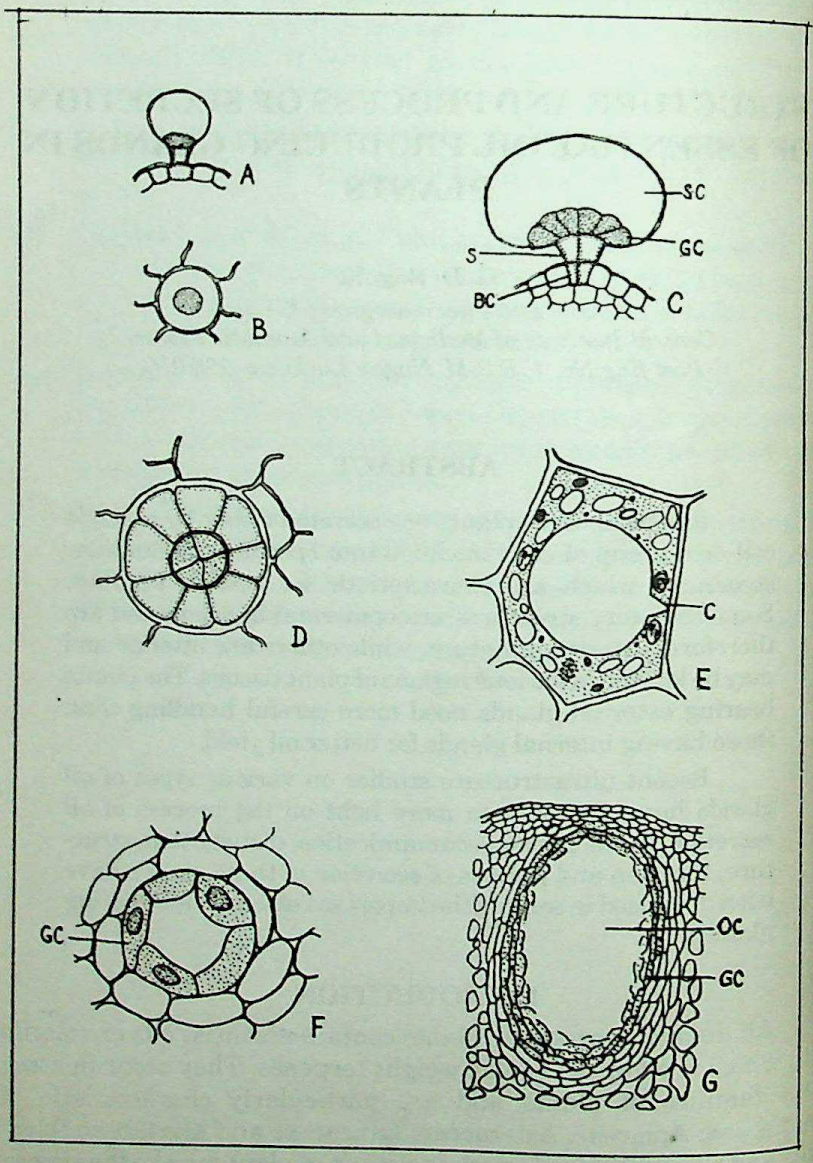
ABSTRACT

Essential oil in plants are secreted either by a single cell or a group of cells modified into specialised glandular structures which are characteristic for certain families. Some secretory structures are epidermal in origin and are therefore, exterior in nature, while others are interior and may be located in various regions of plant tissues. The plants bearing external glands need more careful handling than those having internal glands for better oil yield.

Recent ultrastructure studies on various types of oil glands have also thrown more light on the process of oil secretion. In the present communication, distribution, structure, function and process of secretion of these glands have been discussed in some of the important essential oil-bearing plants.

INTRODUCTION

All distinctly aromatic plants contain essential oils or volatile oils, which are low molecular weight terpenes. They occur in some sixty families of plants and are particularly characteristic of Lamiaceae, Apiaceae, Asteraceae, Lauraceae and Myrtaceae (Metcalfe and Chalk, 1950). Almost any organ of plant may be the source of essential oil. They are secreted in oil cells, in glandular hairs, in secretion ducts or cavities. They are frequently associated with



Secretory structures in plants. A–B – Glandular hair with one glandular cell (A - Side view, B - Surface view); C-D - Glandular hair with many galndular cells (C - side view, D - Surface view); E - Oil idioblast; F - Schizogenous duct; G - Lysigenous cavity. (BC - Basal cell; GC - Glandular cell; OC - Oil cavity; S - Stipe ; SC - Secretory cavity).

gums and resins and themselves tend to resinify on exposure to air. Some secretory structures, such as the glandular trichomes are of epidermal origin and are thus completely external. Others comprise both epidermal and more deep seated tissue and still others, such as glandular ducts and cavities, occur in internal tissues. Recent ultrastructural studies on these glands have helped in understanding their secretion process. In the present article, the structure and mode of secretion in these glands have been summarised.

Structure and secretion of glandular hair or trichomes : Glandular hairs or trichomes which secrete essential oil are common in plants belonging to families Lamiaceae, Solanaceae, Asteraceae and Geraniaceae. They are of various shapes and sizes but consists of two distinct portions, stalk and head. Both can be unicellular to multicellular (Fig. A-D). Head represent the actual secretory part. however, common type of mature glandular trichomes possess an enlarged secretory cavity covered with cuticle and subjacent cell wall formed from the discoid tier of secretory cells subtended by a stipe and supported by a tier of basal cells embeded in the epidermis. Essential oil secreted by the secretory cells accumulate in the secretory cavity (Fig. C) which is actually a sub cuticular space. In some cases all part of the glandular hair including the stalk cells secrete the oil (e.g. *Valeriana callina*) and the secreted oil come out of the cell without getting accumulated in the secretory cavity (e.g. *Atropa belladonna*) or may collect in the intercellular space between the glandular head cells (e.g. *Solanum tuberosum*) (Fahn, 1979).

Secretion of essential oil by glandular hairs or trichomes has been extensively studied in many plants (Bosabalidis & Tsekos, 1982; Bell & Curtis, 1985; Kim & Mahlberg, 1991). It has been observed that when the secretory cells of glandular hair, is still developing and dividing, contain several small vacuoles and plastids which are large, elongated, often lobed and lack a well developed internal membrane system. These plastids contain numerous plastoglobuli and vesicles containing amorphous material. After cell division cease before the onset of secretion, the plastids become smaller, more numerous and more electron dense. Due to fusion with each other, size of vacuoles increase and occupy more area of the cell. At this stage, dense osmiophilic material accumulates in the vacuoles. In mature secretory cells, vacuoles may become completely occluded with the osmiophilic material. But when the secretion begins, the osmiophilic material becomes less electron dense and

granular. At this stage, plastids become intensely osmiophilic and cuticle starts to separate from the cell wall of the secretory cells and form a secretory cavity where, secreted product is accumulated.

The formation of secretory cavity has been studied in the trichomes of *Cannabis sativa* in great detail (Kim and Bahlberg, 1991; Mahlberg and Kim, 1992). It has been observed that during the presecretory period, outer zone of peripheral wall of disc cells become less dense and here membrane bound compressed hyaline areas appear which subsequently spreads to inner zone also. These have electron dense contents, which are released into the secretory cavity, where they form rounded secretory vesicles. Continuous secretion causes further separation and distension of cuticle from the wall of secretory cells. The gland appear to enlarge dramatically but as a result of cuticle expansion and not cell enlargement.

Structure and secretion of oil cells : Essential oil may be produced internally by ordinary parenchymatous cells or by specialized cells commonly called as oil idioblasts. In fragrant flowers (e.g. *Rosa* sp. and *Jasminum* sp.) essential oil occur in the form of minute droplets in the cytoplasm of normal epidermal or parenchymatous cells of petals.

Oil idioblasts are commonly found in the parenchymatous tissues of Zingiberaceae, Piperaceae and Lauraceae. They occur singly or in groups. These cells are relatively larger in size than the surrounding cells of parenchyma. These cells have large oil cavity which are attached by a cupule to the cell wall (Fig. E). Cupule is the bell like projection of the inner cell wall. In oil idioblasts plastids are the probable site of oil synthesis. The oil moves to the outside of the plastids and is released into the ground plasm where it migrates towards the oil cavity and fuses with it. Endoplasmic reticulum serves as a guide for migration of the oil droplets through the cytoplasm towards the plasmalemma surrounding the oil cavity (Bakker & Gerritsen, 1990).

Structure and secretion of oil cavities and ducts : In many instances small groups of thin walled, densely protoplasmic cells secrete oil which are collected in an internal space, which may be more or less isodiametric in shape are called as oil cavities. Sometimes, this space considerably elongates in one plane and forms a duct like structure are called as oil ducts. These cavities and ducts are of two types depending upon their development.

Schizogenous cavities (Fig. F) and ducts originate by splitting apart of the cells at the middle lamella and lysigenous cavities (Fig. G) and ducts originate by actual breakdown or lysis of the glandular cells. In some instances schizogeny may be followed by lysis also. Schizogenous cavities and ducts are characterised by a ring or lining of intact epithelial cells surrounding the cavity or duct. Such structures are not present in lysigenously formed cavities and ducts, instead it has wall remnants of lysed cells in the cavity or duct attached to the living epithelial cells.

In schizogenous glands, it has been observed that osmiophilic material originates in association with the golgi derived vesicles and also in close association with plastids, mitochondria and vacuoles, thereby plausibly involving them also in the process of secretion. Secretion is eliminated from the cytoplasm by membrane bound vesicles. These vesicles fuse with plasmalemma at the inner side of wall and the contents are deposited in the space between the protoplast and wall. Later, the secretion passes through the loose matrix of cell wall into the cavity or duct (Bhatt, 1987).

In lysigenous glands, the cells which are about to disintegrate usually contain high osmiophilic cytoplasm. Dark cytoplasm was noted as a phenomenon associated with destruction or degeneration of cells. The darkening of the epithelial cells is a gradual process which begins in the vicinity of ribosomes. It is actually due to the changes in the cytoplasmic proteins. In these cells, golgi bodies become swollen and are surrounded by many large vesicles, which seem to invade various organelles. It appears that the golgi bodies in the dark cells are involved in lytic process, first in lysing organelles and then, after the cells break down, also dissolves cell remnants, there by releasing the seccretion in the lumen of the cavity or duct (Joel and Fahn, 1980).

The site of synthesis of essential oil varies greatly in different types of glands but wherever, plastids are present in the glandular cells, osmiophilic droplets appear first in them. These droplets were also found associated with rough and smooth endoplasmic reticulum, golgi bodies, mitochondria and even nuclear membrane (Fahn, 1979).

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ENUMERATION OF SOME AROMATIC PLANTS OF LUCKNOW DISTRICT

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ABSTRACT

Aromatic plants as a source of natural perfumes, flavours, cosmetics etc. have always been considered items of curiosity for mankind since time immemorial. The present communication is based on the work pertaining to botanical exploration of Lucknow district, U.P. and deals with the identification and enumeration of 15 such aromatic plants which need proper exploitation for commercial use as a source of aroma chemicals.

INTRODUCTION

The aromatic plants play a very important role in our day-to-ay life as spices, condiments and cosmetics etc. The essential oils r volatile oils derived from these plants are also used for ıerapeutic action as drug, for flavouring, in perfumery or as a tarting material for the synthesis of other compounds.

It is difficult to trace the history as to when man first use the romatic plants but there is no denying the fact that such items have lways remain a subject of curiosity for mankind since time im-ıemorial. The use of aromatic plants as Dhup, Hawan-Samagries ıd offering of fragrant flowers before the deities are religious ractice and cultural heritage of our country (Atal and Kapur 1982). he classical literatures of Indigenous system of medicine - Charak ıd Sushruta Samhita also record the use of such plants, mention ay be made of Chandan (*Santalum album* L.); Agaru (*Aquilaria allocha* Roxb.); Guggul (*Commiphora wightii* (Arn.) Bhand.); gar (*Valeriana wallichii* DC.); Jatamansi (*Nardostachys jataman-* DC.); Ushir (*Vetiveria zizanioides* (L.) Nash (Charak 1970 ;

Sushruta 1966). Undoubtedly, India is bestowed with very rich and varied flora, containing appreciable proportion of medicinal and aromatic plants. A rough estimate indicates that about 10% of the total species of flowering plants constitute aromatic plants (Krishna & Badhwar 1947-53). Inspite of all these, the local flora has been very less worked out for identification of new source of aroma chemicals and their commercial exploitation subsequently.

During the course of working on the flora of Lucknow district the author came across such plants which have distinct fragrance and flowers are generally used as votive of offering in temples and making garlands by local people. The literature survey also indicates that much work has not been done on these plants and as such they require thorough investigation for commercial exploitation.

In the present article, 15 aromatic plants either growing wild or cultivated have been enumerated. The plant species have been arranged alphabetically followed by family name in parenthesis and the common name/local name /english names wherever available. The general distribution, flowering and fruiting period, locality, main chemical constituents and prominent uses as reported in important works or references (Anonymous 1947 - 1976 ; 1976, 198 ; Chopra et al. 1956 ; Hooker 1872-1897) are reported. These plants may prove to be an alternate or main source of some of the important aroma chemicals.

ENUMERATION

1. *Cassulia axillaris* Roxb. (Asteraceae).

Erect or decumbent-ascending annual herb. Leaves narrowly lanceolate, base auricled, serrulate. Heads purplish white or pale blue, axillary, homogamous. Achenes flat, 1-ribbed on each side. Flowering and fruiting : October - January. Throughout Northern India, common weed of paddy fields, ascending to 1000 m. from Punjab to Chittagong and the Deccan. In Lucknow (Bakshi Ka Talab), common weed of paddy and sugar cane fields and other kharif Season crops. (Singh 5910).

Leaves yield 0.45% of essential oil and the main constituents are *gama*)–*asarone* and *limonene* (*Gargetal*.1992).

2. *Carissa spinarum* L. (Apocynaceae) 'JANGALI KARONDA'

Shrub with many diffuse, suberect or scandent branches with straight thorns. Leaves broadly ovate to oblong, entire, acute

Flowers white fragrant, in terminal and axillary corymbose cymes. Fruits ovoid or elliptic, flowering & fruiting : April - June

Throughout India in dry regions especially in Punjab, Kashmir and North West Frontier Province. In Lucknow (Kukrail Reserve Forest, Moosa Bagh) and is common in scrub jungles and along roadsides. Singh 5838, 6224.

3. *Cestrum nocturnum* L. (Solanaceae) 'RATRANI : NIGHT JESAMINE'

Diffuse glabrous shrubs. Leaves oblong-ovate or elliptic, tapering at the ends. Flowers greenish white, in axillary and terminal umbelliform racemes, flowering most part of the year. Native of tropical America, cultivated throughout India for its fragrant flowers which are fragrant during night. Singh 4382.

4. *Feronia limonia* (L.) Swingle (Rutaceae) 'KAITH'

Medium-sized tree bearing thorny branches. Leaves imperipinnate; leaflets ovate or obovate. Flowers palegreen tinged with red in globose pubescent panicles. Fruits globose, rind woody, pulp aromatic. Seeds numerous, flowering and fruiting : April - December.

Native of India and Ceylon. Common in dry situations throughout the plain of India and upto 500 m. in Western Himalayas. Cultivated (Raibareli Road) Singh 6507.

Leaves on steam distillation yield 0.73% of essential oil which is similar to anise and fennel in view of numerous common compounds like thujene. β-pinene, limonene, sabinene, estragole (anethol) and as such it may be a cheaper substitute for anise and fennel oil (Shah et al. 1985).

5. *Hyptis suaveolens* (L.) (Lamiaceae)

Erect large herb or undershrub. Leaves ovate, sinuate and crenate denticulate, slightly cordate, hairy. Flowers blue, 2-4 together on an axillary peduncle or in bracteate axillary racemeform cymes or in some specimen almost leafless panicles; calyx densely glandular hairy, strongly 10-ribbed, corolla bilipped. Nutlets compressed ovoid. oblong, emarginate at tip, flowering and fruiting : October - March. Native of tropical America, introduced into tropical Asia. In India it is found in Deccan Peninsula, Cachar and Nicobar Islands. In Lucknow (Sitapur Road, Kukrail Reserve Forest) and abundantly along roadsides. Singh 5914. Aerial parts of the plant

yield essential oil. The main constituents are l-sabinene, l-limonene menthol, azulenic sesquiterpenes and some unidentified sesquiterpenes and sesquiterpene alcohols (Anonymous 1987). Aerial part of the plant is carminative, stimulant and galactagogue. The essential oil obtained from the plant was active against *Epidermophyton floccosum, Microsporum canis* and *Trichophyton mantagrophytes* at a concentration of 1,000 ppm. The fifty percent of ethanolic extract of aerial part exhibited hypoglycaemic action in rats and anticancer activity against P_{388} lymphocytic leukaemia in mice (Anonymous 1987).

6. *Ixora arborea* Roxb. ex Sm. (Rubiaceae) 'TORCH WOOD IXORA' (Nevari)

Small much branched evergreen tree or shrub. Leaves opposite, subsessile, oblong, 7.5-15 cm long, coriaceous, glaucous. Flowers white or pink in large corymbose terminal cymes, flowering and fruiting : March - May. Throughout the gangetic plain eastward to Assam and southwards to Kerala and Nicobar islands. In Lucknow now it is planted for ornamental purposes. Singh 4476. Flowers pounded in milk and given for relieving whooping cough.

7. *Jasminum sambac* (L.) Ait. (Oleaceae) 'BELA', 'ARABIAN JASMINE, TUSCAN JASMINE'

Scandent or suberect shrub; branchlets pubescent. Leaves variable in shape, usually ovate or elliptic. Flowers white, very fragrant, solitary or 3-flowered terminal cymes, flowering : Summer and rainy season. Cultivated in most part of India for its highly fragrant flowers. Many variants are cultivated in Malihabad and in most part of the district. Singh 4394. Extraction of flowers with petroleum ether yields 0.43% concrete, which gives 26.4% absolute which is deep red in colour and possesses an odour suggestive of jasmine and orange flower. The otto contains benzyl acetate, linalool, methyl anthranilate and indole.

The otto possesses a very pleasing and lasting note and can be employed in the preparation of high class perfumes, cosmetics and toilet soaps. The flowers contain a yellow pigment, used as a substitute for saffron. A lotion made of the flowers is used for washing the face and eyes. The flowers are used in Malaya in application for congestive headache. Crushed flowers are sometimes used as a lactifuge.

8. *Millingtonia hortensis* L.f. (Bignoniaceae) 'AKASHNEEM' 'INDIAN CORK TREE'

Tall handsome tree with narrowly pyramidal crown, yellowish grey rough and corky bark. Leaves 2-3 pinnate; leaflets ovate-lanceolate acuminate, sinuate or crenate. Flowers white or pinkish, fragrant, numerous pendulous in terminal panicles, corolla with long slender tube, flowering : October - November. Native of Burma and Malaya, cultivated for ornamental purposes in Lucknow (Kanpur Road) and other places. Singh 6208. The ethereal and aqueous fractions of the ethanolic extract of fresh flowers yield scutellavein and a new glycoside, scutellarein-5-gallactoside.

9. *Murraya paniculata* (L.) Jack. (Rutaceae)

Evergreen shrub or small tree. Leaves imparipinnate ; leaflets rhomboid or elliptic-lanceolate with an oblique base. Flowers white or cream coloured very fragrant on short axillary and terminal corymbs which borne in bunches of a few to many. Berries ovoid, red or orange when ripe, flowering and fruiting : May - September. Throughout the hotter parts of the country, in subhimalayan ranges upto 1500 m. In Lucknow (Sitapur Road) both wild and cultivated for ornamental purposes or as a hedge plant. Singh 6098. Fragrant flowers contain indole and a bitter crystalline glycoside murrayin which is identical to scopolin & coumarin. In Java, flowers used in cosmetics. Fragrant leaves used as a stimulant, astringent and in diarrhoea and dysentery in Philippines. The fragrant powdered bark is said to be used in Burma and Siam as a face powder.

10. *Nepeta hindostana* Haines (Lamiaceae) 'BILLILOTAN'

Aromatic annual herb with stem obtusely 4-cornered and pubescent. Leaves 2-6 cm long, broadly ovate or ovate, coarsely crenate-serrate. Flowers bluish purple in axillary, dense cymes aggregated at the top of the stem into dense spiciform thyrses. Nutlets oblong light brown with white dots, flowering and fruiting : August - November. Most part of the country ascending to 2500 m. in Himalayas. Common in waste places and crevices of old buildings. Singh 6371. The main constituents are : d- and l-limonene 20.8% methyl heptenone 9.1%, citronellal 17.8%, l-menthone 5.5%, citronellol 13%, geraniol 7.6%, geranyl acetate 13.2% and unidentified sesquiterpenes 4.5%. The plant is reported to be a cardiac tonic and is used in fevers. In Nepal, it is used internally as a remedy

against gonorrhoea. A decoction of the plant is used as a gargle fo sore throat.

11. *Nyctanthes arbor-tristis* L. (Oleaceae) 'HARSHINGAR' 'CORAL JASMINE' 'PARIJAT'

Large shrub or small tree with strigose, quadrangula branches. Leaves ovate, acuminate, entire with a few large distan teeth, rough and scabrous. Flowers white with bright orange corol tube, arranged in trichotomous cymes. Capsules suborbicular, com pressed, flowering and fruiting : June - November. Native of Indi occurring wild in the sub-Himalayan region, from Chenab to Nepa upto 1670 m and in Chhotanagpur, Rajasthan, Madhya Pradesh an Southwards to Godavari. It is cultivated for ornamental purpose in Lucknow (Kukrail Reserve Forest) Singh 6525. The oil from th flowers contained α-pinene, p-cymene, l-hexanol, methyl hep tanone, phenylacetaldehyde, p-decanol and anisaldehyde. Th acetone extract of the corolla tubes yield β-digentiobioside ester α-crocetin as a minor component. Bright orange corolla tubes of th flower contain a colouring matter nyctanthin, which is identical t α -crocetin from saffron, formerly it was used for dyeing silk som times in combination with safflower, indigo etc.

12. *Pogostemon benghalense* Ktze. (Lamiaceae)

Large aromatic herb or shrub. Leaves ovate or rarely lance late, serrate, acute or subacuminate. Flowers pinkish white or pal in capitate secund bracteate spikes which again are arranged i dense secund panicled, villous racemes. Nutlets broadly ellipsoid dark brown. Almost throughout India ascending to 1670 m. in th Himalayas. Not common in Lucknow. Singh 5175. Leaves yiel essential oil, the main constituents are l-menthol, patchouli alcoho aroma dendrene. Oil from plant yields linalool, linalylacetate citronellol, geranyl acetate, geraniol, camphene, limonene etc Fresh leaves styptic, bruished and applied as a cataplasm t wounds; the juice is given in colic fever. Extract of leaves exerte antifungal activity against *Helminthosporium sativum*. The essen tial oil showed mild antifungal activity against *Epidermophyto floccosum, Microsporum canis* and *Trichophyton mentagrophytes*.

13. *Quisqualis indica* L. (Combretaceae) 'RANGOON CREEPER' 'MALTI'

Large, woody scandent shrub. Leaves elliptic or elliptic-oblong acuminate, entire, papyraceous. Flowers white turning to deep re

in axillary or terminal pendulous recemes, flowering and fruiting : Most part of the year. Indigenous in tropical Africa and tropical Indo-Malaysian region, cultivated for its fragrant and showy flowers throughout India upto an altitude of 335 m. Singh 4474. The deep red flowers contain cyanidin monoglycoside.

14. *Salvia plebeia* R.Br. (Lamiaceae)

Erect aromatic deep rooted roughly pubescent, annual herbs with 4-angular and grooved stem. Leaves 2.5-9 cm. long, oblong-lanceolate, crenate. Flowers bluish or purplish white, in panicled usually compact spicate racemes; bracts reflexed. Nutlets ovoid brown, flowering and fruiting : January - April. A common weed throughout the plains of India and in the hills upto an altitude of 1670 m. In Lucknow (Chandika Devi Temple) and is abundant in most places. Singh 6376. Leaves are used for toothache. The herb is employed as a diuretic, astringent and anthelmintic. The seeds are given in case of menorrhagia, diarrhoea, haemorrhoides and are employed to anoint hair to keep them glossy.

15. *Tabernaemontana divaricata* R.Br. (Apocynaceae) 'EAST INDIAN ROSEBAY' 'CHANDNI'

Evergreen beautiful shrub or small tree. Leaves elliptic-lanceolate, acuminate or caudate, entire, smooth and glossy green. Flowers white, fragrant, in axillary and terminal few flowered cymes, flowering and fruiting : Most part of the year. Probably indigenous to India and is found throughout the sub-himalayan tract, from Garhwal eastwards to Assam and Bengal, extending southwards to North circars and hills of vizagapatam. Cultivated as ornamental for fragrant flowers. Singh 6339.

The juice of the flowers mixed with oil is employed for relieving the burning sensation in sore eyes; it is applied also in skin diseases. (Anonymous 1952).

DISCUSSION AND CONCLUSION

The studies carried out sofar revealed that the aromatic plants found growing in and around Lucknow have not been properly exploited for use as aroma chemicals. The species like *Feronia limonia* may be used as an alternative source of anise and fennel and *Jasminum sambac* for prepairing jasmine concrete. Most of the plant species described in the text warrant detailed studies for exploitation of much more commercially used aroma chemicals viz.

geraniol, geranyl acetate, citronellal, citronellol, limonene, styrene acetate, γ-asarone, benzyl acetate, linalool, menthol, l-menthone, patchouli alcohol, anethol, anisaldehide, methyl chavicol etc. The work on species like *Carissa spinarum*, *Cestrum nocturnum*, *Ixora arborea*, *Salvia plebeia*, *Tabernaemontana divaricata* have not been carried out for their commercial exploitation and as such need prime attention. Most of these aroma chemicals not only used as perfumery, cosmetics, flavouring agent but also have many therapeutic properties.

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OBSERVATION ON SOME LESSER-KNOWN INDIGENOUS PLANTS USED FOR ESSENTIAL OILS BY THE TRIBALS OF UTTAR PRADESH, INDIA

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ABSTRACT

Investigations on the natural resources and ethnobotanical lore of certain tribes like Tharu, Gond, Jaunsari, Kol, Kharwar inhabiting the forests areas of the Kheri, Naini Tal, Varanasi, Mirzapur, Gorakhpur, Gonda, Bahraich and Dehra Dun district of U.P. have brought to light 26 indigenous plant species used for extraction of essential oil by these tribes for meeting requirement of their day-to-day life and health care. The study has provided new knowledge on the traditional uses of many essential oil plants like *Ageratum conyzoides, Artabotrys hexapetalus, Acorus calamus, Ocimum americanum, Clausena pentaphylla, Chenopodium ambrosioides, Cyperus' rotundus, C. scariosus, Nepeta hindostana, Feronia limonia, Micromeria biflora, Hesperethusa crenulata, Nyctanthes arbortristis, Tridex procumbens, Tagetes minuta,* etc., which need chemical and biological evaluation for proper utilization in essential oil industry. There is enormous potential of raw materials in the state, needed for establishing essential oil industry in the tribal pockets for their socio-economic uplift and providing self employment scheme on cultivation and domestication of some potential aromatic plants.

INTRODUCTION

Essential oils are natural products which form vital constituent of many cosmetic and medicinal preparations. In cosmetics, essential oils are mainly responsible for fragrance. The oil constituents, like eugenol, thymol, asarone, polygodial, etc. smell intensively and possess antiseptic and medicinal properties. Essential oils are complex mixtures of odorous and steam volatile compounds present in the glandular hairs, oil bodies, in idioblasts, in excretory cavities, canals and in heartwood of many plants belonging to family Asteraceae, Juglandaceae, Lamiaceae, Cannabiaceae, Lauraceae, Chenopodiaceae, Myrtaceae, Meliaceae, Rosaceae, Rutaceae, Anacardiaceae, Apiaceae, Poaceae etc. Many wild aromatic plants play a vital role in the life and economy of the tribals of Uttar Pradesh.

The authors are engaged in the ethnobotanical studies of the tribals and aboriginal population of Uttar Pradesh (Maheshwari *et al.*, 1981, 1986). While conducting ethnobotanical studies on the tribals and aboriginal population of U.P., attention was given to record aromatic plants used by them in their life and health care. The studies have brought to light new knowledge on traditional uses of many aromatic plants by them. Essential oils are being increasingly used in aromatherapy, steam tub for tranquility, relaxing tension, beautification of skin and pleasure of mind.

MATERIAL & METHODS

The information on the traditional uses of aromatic plants have been gathered from experienced persons, the tribal chiefs, vaidyas and foresters of the area surveyed. Crude distillation methods of the aromatic plants is prevalent among the tribals and rural population for obtaining the essential oils. The aromatic plants are arranged alphabetically giving information pertaining to their common name, family, parts used, chemical constitution of the oil and their uses.

OBSERVATIONS

The tribal and rural population of Uttar Pradesh collect and utilise the leaves, flowers, roots, rhizomes, bark exudates of many aromatic plants based primarily on the aroma, and also supply them to forest contractors and sell in the local markets for their livelihood.

ENUMERATION OF PLANTS

1. *Abies pindrow* Royle

Family	: Pinaceae
Common names	: Morinda, Rogha, Rausla
Part used	: Fresh needles
Chem. comp. of oil	: α-pinene, l-limonene, carene, dipentene, l-cadinene, l-bornyl acetate.
Uses	: Antiseptic, sedative and in havanas.

2. *Acorus calamus* Linn.

Family	: Asteraceae
Common name	: Bach
Part used	: Rhizome
Chem. comp. of oil	: Asarone, calamen, calameon, calamenol, chlorin, eugenol methyl ether, shyobuneone, epishyobunene, iso shyobunone, 9-aristolene, α-gurjunene, acolamone, iso acolamone and iso calamendiol.
Uses	: In bronchial asthma, in anti lice preparations and in havan samagri.

3. *Ageratum conyzoides* Linn.

Family	: Asteraceae
Common names	: Dochunty, Kukrondhi
Parts used	: Leaves and flowers
Chem. comp. of oil	: Ageratochromene, 6-demethoxy agerato chromene, caryophyllene, γ-cadinene.
Uses	: Essential oil with powerful nauseating odour, antiseptic, applied to cut and sores.

4. *Artabotrys hexapetalous* (Linn. f.) Bhandari.

Common names	: Hara champa, Katheri champa
Part used	: Flowers
Uses	: In perfumery

5. *Boeninghausenia albiflora* (Hook) Reich ex. Meissn.

Family	: Rutaceae
Common names	: Pissubuti, pissughas
Part used	: Leaves

Chem. comp. of oil : β-phellandrene, terpinen-4-ol, γ-terpinene ocimine,β -caryophyllene, zingiberene cadinene, α-ionone.

Uses : Insecticide to kill lices and dandruff.

6. *Centella asiatica* (Linn.) Urban

Family : Apiaceae

Common name : Brahmi

Parts used : Fresh leaves, whole plant

Uses : Leaves taken as such for improving memory, in leprosy and skin diseases.

7. *Cedrus deodara* Roxb. ex G. Don.

Family : Pinaceae

Common name : Deodar

Part used : Wood

Chem. comp. of oil : Methyl tetra hydroacetone, α-himachalene β-himachalene longiborneol, himachalol centdarol, deodarone etc.

Uses : In skin diseases and for ulcers.

8. *Chenopodium ambrosoides* Linn.

Family : Chenopodiaceae

Common name : Kiramari

Parts used : Whole plant, flowers and fruit

Chem. comp. of oil : α-terpene, p-cymene, ascaridol, β-pinene, (-) pinocarveol

Uses : Plant used in piles, oil against hookworm.

9. *Clauscena pentaphylla* (Lank.) Tanaka

Family : Rutaceae

Common name : Ban nimbu

Part used : Leaves

Uses : Anti inflammatory and as an insecticide.

10. *Chloroxylon switenia* DC.

Family : Rutaceae

Common name : Birrha

Parts used : Leaves and stem.

Uses : Astringent, antiseptic and in rheumatism, also as an insecticide.

11. *Cyperus rotundus* Linn.

Family : Cyperaceae
Common name : Motha
Part used : Tubers
Chem. comp. of oil : 27 compounds isolated by GLC: pinene, 1:8 cineole, cyperene, isocyperol, patchoulenone, mustakone, copaene, copadiene, epoxy guaiene, rotundone, cyperolone, sugeonol, α-selinene.
Uses : In rheumatoid arthritis.

12. *Cyperus scariosus* R. Br.

Family : Cyperaceae
Common name : Nagarmotha
Part used : Tubers
Chem. comp. of oil : Rotundene, rotundenol, α-selinene, iso-patchoula 3, 5 diene
Uses : In medicines, dhoops, havan samagri, agar batti

13. *Cymbopogon jwarankusa* Schult.

Family : Poaceae
Common names : Jarankush, Karankusa, Karanjak
Part used : Leaves
Chem. comp. of oil : Piperitone, car-4-ene, carene, β-caryophyllene, p-cymene, piperitol, perillyl alcohol
Uses : In rheumatism and malaria fever.

14. *Feronia limonia* Linn.

Family : Rutaceae
Common name : Kaitha - Kavitha
Parts used : Fruit and leaves
Chem. comp. of oil : Limonene, estragole
Uses : Carminative

15. *Glycosmis pentaphylla* Correa

Family : Rutaceae

Common name : Ban nimbu
Part used : Leaves
Uses : Antiseptic, in cholera

16. *Micromeria biflora*
Family : Lamiaceae
Common name : Oti-buduba
Part used : Whole plant
Uses : Carminative, in stomach disorders.

17. *Murraya koengii* (Linn.) Spreng.
Family : Rutaceae
Common names : Kathnim, mithi neem
Part used : Leaves
Chem. comp. of oil : Phellandrene, sabinene, α-pinene, dipentene, caryophyllene, cadinol, iso safrol
Uses : Applied to cure eruptions, decoction given in bites of poisonous animals and also used as spice

18. *Naringi crenulata* (Roxb.) Nicolson
Family : Rutaceae
Common name : Belsondha
Part used : Leaves
Uses : Aromatic, antiseptic, also used in aggarbattis

19. *Nyctanthes arbortristis* Linn.
Family : Oleaceae
Common name : Harsingar
Parts used : Leaves and flowers
Uses : Decoction in intestinal worms, laxative, in malaria

20. *Nepeta hindostana* (Roth) Haines
Family : Lamiaceae
Common name : Badrangboya
Part used : Whole plant

Chem. comp of oil : l-limonene, methyl heptenone, citronellal, linalool, geraniol, l-menthone, geranyl acetate, sesqui terpenes

Uses : Mosquito repellant

21. *Ocimum americanum* Linn.

Family : Lamiaceae

Common name : Ban tulsi

Part used : Whole plant

Chem. comp. of oil : Camphor, citronellol, linalool, linalyl acetate, methyl cinnamate, eugenol, borneol, citral, methyl heptemone, geraniol, dipentene, limonene, α-pinene, sabinene, caryophyllene.

Uses : In fever, snake bite and perfumery.

22. *Origanum vulgare* Linn.

Family : Lamiaceae

Common name : Sathra

Part used : Whole plant

Chem. comp. of oil : Thymol, α-thujene, camphene, α-pinene, myrcene, ocimine, β-phellandrene, α-terpineol

Uses : In colic pain, rheumatism, toothache etc.

23. *Ruta graveolens*

Family : Rutaceae

Common names : Sadab, somlata

Part used : Leaves

Chem. comp. of oil : α-pinene, sabinene, myrcene, caryophyllene, bergamottene, γ-elemene, α-cyclocitral, phenyl ethyl butanoate, cimmamyl iso valerate, tridecan-2-4-dione, heptadecan-2-dione.

Uses : Stimulant, diuretic and nerve tonic.

24. *Tagetes minuta* Linn.

Family : Asteraceae

Common name : Jangli gainda

Part used : Whole plant

Chem. comp. of oil	: Limonene, ocimene, myrcene aromadendrene, linalool, linalyl acetate linalool monoxide, carvone, 1:8 cineole salicylaldehyde, ociminone
Uses	: In ear ache and as an insecticide.

25. *Tridax procumbens* L.

Family	: Asteraceae
Common name	: Phutenti
Part used	: Whole plant
Uses	: Antiseptic, mosquito repellant

26. *Vetiveria zizanioides* (L.) Nash

Family	: Poaceae
Common names	: Khus, seenk
Part used	: Roots
Chem. comp. of oil	: Vetivone, vetiverol, vetiverone, vetive oxide, bisabolene, iso bisabolene
Uses	: Antiseptic, refrigerant, in fever, essence a tonic.

27. *Zanthoxylum alatum* Roxb.

Family	: Rutaceae
Common names	: Tumru, timur
Part used	: Fruit
Chem. comp. of oil	: Linalool, dipentene, cinnamic methyl ester citral, geraniol, limonene, selinene
Uses	: In tooth ache, fever, cholera, dyspepsia

DISCUSSION & CONCLUSION

The study has brought to light new knowledge on some aromatic plants used in medicine and for extracting essential oils. The various new lead of organic compounds and the essential oils is of great value in perfumes, cosmetics, medicines, and flavouring agent. Some of these wild aromatic plants should be domesticated and cultivated for improving the economy of the tribals and rural population of the state. There is anormous potential of aromatic plants in the state, needed for establishing essential oil industry in the tribal tract of U.P. for the benefit of tribal and rural population

Further, many cooperative stores and herbal farms should be established in the tribal tract under self employment scheme for them.

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DIVERSIFICATION OF AGRONOMIC RESEARCH ON ESSENTIAL OIL BEARING PLANTS IN INDIA

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ABSTRACT

This paper highlights what is to be done with respect to agronomic research in order to find out lasting solution of immediate as well as long term problems. The diversification in the research approach have been emphasised which mainly includes cropping system-based research for the various non-monetary and monetary inputs rather than continuing on individual crops, accommodating these crops in rotations or as intercrops with traditional agricultural crops and/or plantation crops, integrated and cost effective pest management, developing irrigation and harvesting schedule and development of package of practices of suitable aromatic crops for their cultivation on different type of wastelands/marginal lands.

India is having diversified soil and climatic conditions whic favour the cultivation of different essential oil bearing indigenou and exotic plant species. But prior to sixties, India had been th major importer of most of the essential oils used in cosmetic an perfumery industries. Essential oils of indigenous plants like sandl wood, palmarosa, lemongrass and vetiver, were, however, exporte to the international market since the beginning of this centur During last three decades the research emphasis was directe towards agronomical developments for cultivation of commercial viable indigenous plants and introduction & commercialization

economically viable exotic plants. As a result India became self sufficient in Japanese mint, spearmint, and citronella (Java) oil production and is now in position to export substantial quantities of these oil in international market.

Research work carried out recently at the Central Institute of Medicinal and Aromatic Plants, Lucknow indicates tremendous potential of some of the aromatic grasses like lemongrass, vetiver and palmarosa in various kinds of salt affected soils (Singh and Anwar, 1985; Singh *et al.*, 1987) and agroforestry system (Singh *et al.*, 1985; 1990). Diversification of cultivation of these crops to new potential areas will be helpful in minimising pressure on arable land.

Crops are grown in sequence and preceding crop may affect substantially the input (fertilizer, irrigation, herbicide etc.) requirement, planting and harvesting of succeeding crop. But most research effort in the past have been directed on increasing productivity of individual crop without any consideration to the preceding crop, resources available with the farmer's and farm out put as a whole. For promotion of cultivation of essential oil bearing crops it is necessary to develop the most appropriate cropping system involving traditional agricultural crops for different agroclimatic regions. Recommendations based on research work carried out on individual crop have limited use as they are seldom followed. The argument that the results of experiments on individual crop may be extrapolated to fit in a particular cropping system is vague and does not hold much promise.

Planting time and crop geometries are crucial factors in crop production and have been worked out for most of the commercially viable aromatic crops. But optimum plant population depends largely on soil fertility, interculture operations, etc. In fertile soil a wider spacing is desirable as compared to that in soils of low fertility. High planting density of perennial aromatic grasses like citronella Java, palmarosa, lemongrass, etc. is desirable for obtaining high yield in the first year. This will not only ensure efficient utilisation or natural resources like sunlight, nutrients, water, etc. but also mininise weed problem which is severe during the period of crop establishment. The level of plant population may be reduced in second year through removal of alternate rows, if required.

Planting time of a particular crop species must not be considered in isolation. The optimum planting time should be worked

out keeping in view the crop rotations to be followed in a particular region. Several field studies indicated January-February as the optimum planting time for Japanese mint. But the crop is seldom planted during that period. This is because of interference with the *rabi* season crop. Farmer's mostly plant it after harvest of *rabi* crop *viz*. potato, pea, mustard, etc. although there is reduction in both herb and oil yields. Intensive research efforts are needed to minimise such yield losses. Transplanting of seedings raised in the nursery may be a solution to the vexed problem but needs detailed investigation. Recently, it was found that shifting of planting time of citronella Java from July-August to February-March is beneficial (Singh *et al.* 1991) under terai conditions of U.P. as such a practice enables higher oil yield, particularly in the first year. This is a commendable achievement and indicates the role of non-monetary inputs in enhancing crop growth.

Nutrient management is another area which has received much attention of the agronomists during the last three decades. The amount of fertilizers (N, P and K) required for productivity maximization has been worked out for different situations. Several methods have been suggested to increase efficiency of applied nutrients like use of urea super granules or neem coated urea in place of prilled urea, split application of N and K, band placement of P. While little attention was paid to work out fertilizer requirement on the basis of cropping system. Furthermore, nutrient requirement of crops grown in specific situations like salt affected soils, dry land and other culturable wastelands have been mostly ignored. The future research in this area should precisely be directed towards (i) working out critical nutrient levels in both soil and plant for increasing nutrient use efficiency, (ii) studying possibility of recycling of nutrients through incorporation of distillation waste (directly or through composting for further enrichment of nutrient value) in soil, and (iii) developing process for early diagnosis of micronutrients, particularly Fe and Zn, deficiency in plants and their remedies.

Aromatic crops respond well to supplemental irrigation. But the entire field of water management has been neglected in the past. Adequate emphasis should be given to work out the optimum water requirement of different crop species grown on specific situations to avoid the problem of both over and under irrigation. This will ensure efficient utilisation of the water resources. In studies carried out on

aromatic crops, mostly irrigation schedule has been suggested on the basis of interval of days between irrigations. But this does not seem to be based on scientific criteria. Efforts should therefore be made to work out optimum IW/CPE ratios for important crops for developing irrigation schedule. Some crops like palmarosa, lemongrass, etc. perform well even with less availability of water. But no information is available regarding agronomic practices for their cultivation in dry land areas.

Weeds are of major concern for successful crop production. They not only reduce crop yield but also affect the quality of produce. Therefore, periodic weed removal is a must and is accomplished manually in our country. Manual weedings, however, are getting costlier, cumbersome, and labour intensive. Herbicides are used frequently in agricultural crops for attaining satisfactory control of weeds. In the past, several herbicides were screened for different aromatic crops. It has been found in majority of the cases that herbicides alone are not sufficient for obtaining desired results. Emphasis, therefore, should be laid on developing integrated weed management comprising of manual weeding, interculture operations, mulching, herbicide, in future studies. Similarly, information should also be generated on critical periods of crop-weed competition for different crops.

In essential oil bearing crops, secondary metabolites are the economic products, it is necessary to develop proper harvest schedule for ensuring higher oil yield with superior quality. It requires understanding of several factors like (i) effect of harvesting on oil yield and quality, (ii) its influence on persistence of higher yield in subsequent years, etc. Thorough knowledge of the life cycle of leaves, their origin, expansion to full development and finally loss through senescence is particularly important for crops in which leaf contain valuable (economic) product. The proper time of harvest is difficult to assess in these crops due to absence of distinct symptoms of maturity and indeterminate growth habit. Among the different criteria for harvesting, flower initiation and flowering, leaf shedding, harvestwise days interval, deserves further alternation.

In our country, about 94 million hectares of land is considered to be wastelands. The area under this category is increasing rapidly due to mismanagement of the agroecosystem. The cultivation of agricultural food crops in these soils is not remunerative

unless the soil is reclaimed. Some aromatic crops are, howeve suitable for cultivation in different categories of waste lands (sa affected soils, waterlogged and marshy area, mining industri wastelands, undulated upland and land with steep slope) witho any use of soil amendments. Palmarosa, vetiver, lemongrass, ha shown salinity and sodicity tolerance (E.C. 10-11.5 dsm^{-1}). Th demonstration trials at Lucknow under wasteland developme programme have also shown successful cultivation of these grass in alkali soils of pH 9.5. Lemongrass thrives well in slopes, ravine and poor marginal soils, and vetiver could be grown in waterlogge soils.

The agronomic practices for obtaining economic optimum yie of these crop grown in these waste lands have to be developed in th near future for realisation of full potential of these poor soil. Furthermore, the ameliorative potential of these crops for salini (chloride and sulphate), sodicity (RSC and SAR), toxic elemen (boron and fluorine) and moisture stress, etc. need to be investigate before suggesting long term cultivation of these crops under specif situations. Moreover, other aromatic crops, German chammomil (*Matricaria chammomilla*), scented rose (*Rosa damascena*) a eucalyptus (*Eucalyptus citriodora*) are of importance in this conte but little work has been done on their agronomic management f essential oil production.

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HARVEST MANAGEMENT FOR AUGUMENTING CITRONELLA PRODUCTION

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ABSTRACT

Studies on different aspects of the harvest management; (i) Age of harvesting, (ii) Harvesting cycle, (iii) Frequency of harvesting and (iv) Height of cutting were undertaken under complete rainfed condition at RRL, Bhubaneswar during 1989-92. The finding revealed that : (i) Citronella harvested from 3 months to 15 months of age recorded high production peaks at 6, 9, 10 and 14 months of crop age, (ii) 6 to 9 and 12 months grown crop harvested at January - July, February - August, March - September, April - October and July - January harvesting cycles recorded maximum rate of oil production, (iii) Citronella harvested at the frequency of 6 & 9 months was prefered over 3 & 12 months and top cutting method of harvesting was to be practised against bottom cutting to augment Citronella production.

INTRODUCTION

Citronella has been aclimatised in the Aromatic and Medicinal plants Garden of RRL, Bhubaneswar since last two decades. The trial cultivation and other agronomical studies could establish the economic potential of this species. But the plant growth pattern exposed the roots and under ground condensed stem region due to loose and lateritic soils of the region in course of prolonged crop growth period. The bottom harvesting (6"-8" above ground) also increased the incidence of *Fusarium wilt* and crop mortality due to harvesting shocks. Though nitrogen application enhanced crop

production (Bommegowda *et al.*, 1983), the quality and quantit improvement through hybridization had its limitation (Kole, 1985 Hence, harvesting management studies were undertaken to aug ment citronella production.

MATERIALS AND METHODS

A study was conducted on age of harvesting and the crop wa harvested at 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 months of age The observations on plant growth parameters, herb age and o yield were recorded. A study was also conducted on Age-cum seasonal harvesting cycle in citronella. The crop grown for th periods of 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 months were harveste at harvesting cycles of January – July, February – August, March September, April – October, May – November, June – Decembe July – January, August – February, September – March and Octob – April. The growth and productions were recorded. The harvestin frequency in citronella was investigated at the age of 3, 6, 9 and 1 months and the rate of herb production was recorded. A study o height of cutting was initiated by bottom and top cutting (1" abo last leaf) to know its effect on crop production and the crop stand

RESULT AND DISCUSSION

Age of harvesting :

The observations on age of harvesting have been recorded i (Table 1). July planted, three month old citronella recorded 112 cm height, 10 tillers per clump and herb yield of 6.1 tonnes per hectare The plant height gradually increased to 143 cm. in January, the reduced till June, which was due to soil moisture stress and agin of leaf. With the onset of monsoon the height increased from 139 t 193 cm. during July to September. Unlike plant height the tille number per clump increased with the age of crop (10-52 nos.) an then remained stable during 13 to 15 months of age. The cro harvested during winter to summer (6 to 12 months) recorded hig oil content (1.4 - 1.60%) as against low oil content (1.10 - 1.15%) i aged, rainy season harvests, due to leaf moisture content.

Table 1 : Growth, oil content, herb and oil yield of citronella with its crop age.

Months of harvesting	Age (months)	Plant Height (cm)	Tiller number per clump	Oil Conent (%)	Herb yield (t/ha)	Oil yield (lt/ha)
September	3	112	10	—	6.10	—
December	6	125	15	1.50	10.6	159.00
January	7	143	16	1.47	7.8	113.10
February	8	142	30	1.40	8.0	112.00
March	9	125	32	1.60	10.8	172.80
April	10	118	41	1.61	11.8	189.98
May	11	117	40	1.50	8.2	123.00
June	12	113	41	1.60	7.4	118.40
July	13	139	52	—	16.0	—
August	14	120	49	1.15	21.8	250.07
September	15	193	48	1.10	7.6	83.60

The herb yield increased from 6.1 to 11.8 tonnes per hectare with increase in age of the crop and then reduced in summer months (May - 8.2 t and June - 7.4 t). The low yield in summer was due to more number of dry leaves in the herb. Though the early rainy season aged crop (13 & 14 months) yielded more (16.0 & 21.8 t), the sharp decline of fresh herb yield in September (7.6 t) was due to burning of leaves infected with *Fusarium wilt.* The oil yield was maximum (189.98 lt.) in April at the crop age of 10 months. Though the oil content decreased, but due to high herb production oil yield obtained was maximum (250.07 lt.) in August harvest.

Harvesting Cycle :

The growth parameters did not show appreciable differences except herb production (Table 2). Among the Harvesting Cycles, January - July, February - August, March - September, April - October and July - January recorded maximum rate of oil production i.e. 15.87, 15.06, 13.74, 13.71 and 12.29 lt/ha/month respectively. The study suggested that citronella production could be increased when harvested after 6 to 9 and 12 months of initial growth period with the above said harvesting cycles.

Table 2 – Growth oil content, herb and oil yield of citronella at different harvesting cycles.

Harvesting cycle	Total duration of crop	Plant height (cm)	Tiller No./ clump	Oil content	Total herb yield (t/ha)	Total oil yield (lt/ha)	Rat of o prod uctio per mon (lt)
January–July	18	155.3	32.7	1.55	18.43	285.67	15.8
February–August	19	164.5	42.7	1.34	19.44	260.52	13.7
March–September	20	152.6	37.0	1.56	19.31	301.16	15.0
April–October	15	153.4	42.1	1.35	15.26	206.04	13.7
May–November	16	156.7	40.6	1.10	17.47	137.12	8.5
June–December	17	152.2	40.2	1.36	11.70	159.12	9.3
July–January	18	147.1	42.2	1.60	13.83	221.28	12.2
August–February	19	167.0	47.0	1.10	15.27	167.92	8.8
September March	20	159.5	40.1	1.18	18.09	213.46	10.6
October–April	15	182.8	47.3	1.10	11.44	125.84	8.3

Frequency of harvesting :

Citronella harvested at 3, 6, 9 and 12 months interval record the maximum herb production (152.98 t) for 9 months interval harvesting followed by 12 months (138.72 t), 6 months (121.02 t) a 3 months (65.56 t/ha) in a total crop growth period of 29 months

Height of cutting :

In an exploratory study, though the bottom cutting record higher oil production (23.84 lt.) per cutting than the top cutti (11.54 lt.) the results of varietal evaluation recorded high mortal (50-60%) in bottom cutting after first year under rainfed conditi

Sahoo, *et al.* 1992). The poor crop stand was mainly due to severe infection of *Fusarium* and dry season harvesting shocks.

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PATCHOULI : A NEW AROMATIC HERB FOR ORISSA

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ABSTRACT

Patchouli (*Pogestemom patchouli* Pellet. var. *sauvis* Hooh. F.) on hydrodistillation produces essential oil containing mainly patchouli alcohol used as a high grade perfume. Its oil is mostly imported to meet the indigenous demand of the country. This imported aromatic herb was introduced at RRL, Bhubaneswar during the year 1988, by procuring planting material from CIMAP Regional Centre, Bangalore. Studies on performance in relation to crop age indicated that production can be ehnanced by harvesting the crop at the age of 5 months of planting with a plant density of 12,300 plants per hectare as pure crop. The fresh herb yield obtained was 11 to 15 tonnes per hectare with a leaf : stem ratio of 1.2 to 1.5, oil content of 0.9 to 1.3 per cent and stem 0.2 to 0.3 per cent respectively. The herb contains 80-85 percent moisture. The crop coppiced at 30 cm. radius recorded maximum herb production (15.2 tonnes/ha) as compared to leaf plucking method (4.9 tonnes/ha).

INTRODUCTION

The oil of patchouli is used in essential oil industry for blendi with the oils of vitiver, sandal-wood, geranium and lavender. Abo 90 per cent of the world production (500 tonnes) of this oil is obtain from Indonesia (Robbins, 1983) and the rest from China. India importing about 60 tonnes of oil annually valued at Rs. 3 crores meet the requirement of the industry. Hence, its agrotechnolo development will have a direct impact for production of patcho oil in India.

Table : 1
Growth and yield of Patchouli in different studies

(a) Age of cutting :

Crop age (months)	Herb yield (t/ha.)	Oil content (% f.w.b.)	Oil yield (Kg./ha.)
4	11.88	0.50	59.40
5	14.04	0.53	74.41
6	13.72	0.54	74.09
SEM	0.473	0.019	2.077
C.D. (5%)	1.457	N.S.	6.399

(b) Population density :

No. of plants/ha	herb yield (t./ha.)	Oil content (% f.w.b.)	Oil yield (Kg./ha.)
27,778 (60 × 60 cm)	7.78	0.53	41.23
17,788 (75 × 75 cm)	7.50	0.57	42.75
12,345 (90 × 90 cm)	7.69	0.50	38.45
C.D. (5%)	—	0.038	—

(c) Planting environment :

Shade	5.40	0.42	22.68
Open field	11.74	0.47	55.18

(d) Harvest management :

	Total herb yield (t/ha)	Fresh leaf/stem stem ratio	Leaf oil content* (%)	Stem oil content* (%)
1. 10 cm. above	11.20	1.2	0.90	0.21
2. 30 cm. above	15.20	1.5	0.96	0.30
3. Defoliation except tips	4.90	—	1.00	—
4. Complete defoliation	4.20	—	1.20	—

* Oil content of 3 days shade dried herb

MATERIAL AND METHODS

The field experiments comprised of three population densitie (i.e. 27,775; 17,778 & 12,845 plants/ha) three age of crop (i.e. 4, 5 6 month old crop), four harvest techniques (i.e. coppicing at 10 an 30 cm. above ground level, complete defoliation & defoliation excep growing tops) along with sole and mixed crop with *Leucaen leucocephala* were conducted on Patchouli *(Pogestemon patchoul* at RRL, Bhubaneswar (Orissa). Rooted cuttings were procured fro CIMAP Bangalore for conducting this field trial. The yield data wer recorded in terms of yield of herb and oil, oil content (F.W.B.) an are presented in Table -1.

RESULTS AND DISCUSSION

Age of harvesting :

Earlier studies conducted at RRL, Bhubaneswar showed goo foliage growth. Results of the study showed that 5 months old cr gave significantly higher herb (14.04 tonnes/ha/yr) and oil yie (74.41 kg/ha/yr) over 4 months old crop, though it was at par with months old crop. The litle reduction in growth and yield in 6 mont old crop was mainly due to over maturity and shedding of leave So, harvesting at 5 months age was suggested which confirmed th findings of Sarwar *et al.* (1983).

Population density :

The results of the study indicated that there was no significa difference in yield in between the treatment, spacing at 75x75 cm (17,778 plants/ha) gave the maximum oil yield of 42.75 kg/ha due higher oil content.

Planting environement :

Patchouli being a shade loving herb was planted und *Leucaena leucocephala* as a mixed crop and as a pure crop. The pu crop yielded 2.5 times more oil (55.18 kg) than the mixed crop (22.6 kg/ha). Under the climatic conditions of Bhubaneswar in gener patchouli has given higher herb and oil yield in open fields. Saha *al.* (1989), successfully introduced and cultivated Patchouli in th open under Itanagar conditions.

The patchouli crop recorded good growth under hot and humi condition and seems to be sensitive to harvest injury. The cr

coppiced with 30 cm. radius from plant base gave the maximum herb production (15.2 tonnes/ha) with a high leaf-stem ratio (1.5), the oil content in the leaves and stems being 0.96 per cent and 0.30 per cent respectively. This harvesting prodedure also gave higher yields (unpublished data) in the subsequent harvest. The completely defoliated plants gave minimum leaf yield with an oil content of 1.2 per cent, but regeneration was poor and the performance of the crop in the subsequent harvest was poor.

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IMPACT OF PLANT DISEASES ON ESSENTIAL OIL PRODUCTION

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ABSTRACT

Diseases make alterations in the metabolic activities of plants. In general, it affects the vitality of the plant. Altered metabolic activities not only adversely affect the yield but sometimes it deteriorates the quality of the natural product. Therefore, evaluation of plant health is essential for improving crop yield.

Japanese mint oil is evaluated with the content of menthol. The deterioration in plant health of *Mentha arvensis* due to the leaf-spot disease caused by *Corynespora cassiicola*, brings down the oil yield up to 51.2% depending upon the severity of the disease and virulence of the pathogen. Menthol content decreases from 62 to 13%, while that of menthone increases with the severity of the disease which adversely affects its oil economy. Diseases of *Eucalyptus, Ocimum* spp., Lemongrass, Palmarosa and Java citromella are discussed.

INTRODUCTION

A healthy plant is considered to tolerate various bi physiological and environmental impacts, which affect its hea The degree of tolerance varies upto resistance or immun Tolerance/resistance in plants depends upon the physiolog responses disturbing or altering its metabolic activities. The ag the plants, temperature, humidity, day length, light intens mineral absorption, plant harmones, herbicides, growth retarda

injuries and presence of micro-organisms greatly affect physiological phenomenon of plants.

Plants are the major source of natural products to serve mankind in various ways. Obviously, the healthy crop of plants maintain the yield and its quality. Hence, evaluation of plant health is essential for improving productivity.

Essential oil bearing plants too, are affected by various diseases. Effective control measures are therefore, essential to maintain the yield and quality of oil. The pathological studies on some important essential oil bearing plants indicated that plant diseases directly affect the yield of oil and its quality. It is all the more evident in case when an economically important crop repeatedly suffer with a disease. Disease epidemics may destroy the crop entirely.

Japanese Mint Diseases

It belongs to the family Lamiaceae and yield mint oil. *Mentha arvensis* var. *piperascens* L. is an important essential oil bearing plant (Anonymous, 1962). Its oil is a rich source of menthol which is used as a chief flavouring constituent of tooth-paste, candies, chewing gums and mouth washes. It also possesses soothing medicinal qualities and widely used in ointments, pain balms, cough syrups, cough lozenges and in various other medicines (Atal et al. 1982).

The fresh leaves of *M. arvensis* contain 0.4 to 0.6% oil, which constitute 70-72% menthol, 7-17% menthone, 12-15% menthyl acetate and 5-10% other terpenes. Menthol content is the basis of conventional evaluation of the oil in trade.

Table : Effect of disease intensity on mentha oil and its major constituents.

Severity of Disease	*Oil yield Wt/V (%)	Loss (%)	% of		
			Menthol	Menthone	Menthyl acetate
Healthy	0.82	—	62.78	1.96	27.37
1–25	0.73	11.1	52.36	6.87	39.89
26–50	0.64	22.2	50.07	10.37	37.88
51–75	0.58	41.4	21.18	42.49	28.12
76–100	0.40	51.2	12.98	60.07	16.48

*on fresh weight basis

Leaf-spot : This disease of *M. arvensis* incited by *Corynespor cassiicola* causes heavy loss to the crop particularly in Terai regio of Northern plains of the country (Singh, 1984). The disease appea with the onset of monsoon season in the form of small chloroti spots, which turn dark brown, enlarge and coalesces to cover larg area of leaf followed by defoliation. Incidence increasing with th advancement of plant age. The observations presented in the Tab indicated an oil loss upto 51.2%, the menthol content fell to 12.9 while menthone increased to 60.01%. Thus gradual deterioration oil quality takes place with the severity of the disease. The foli sprays of Difolatan (0.2%) and Benlate (0.1%) reduced the disea index by 67.3 and 62.8%, respectively, which resulted in an increa in herbage yield by 175.12 and 163.52 Q/ha over 135.9 Q/ha untreated crop.

Powdery Mildew : It is caused by *Erysiphe cichoracear* DC. (Ganguli & Pandotra in 1962). It causes heavy damages to crop and reduces the oil yield by 20%. It appears as small necr spots on the dorsal surface of the leaf which become brownish at corresponding lower side gives powdery appearance. Further death eventually affects the oil yield. Sulphur dusting or its sp at the rate of 0.5% solution, Hexasul and Karathane WDA percent) at 10-15 days interval, was found effective in control the spread of the pathogen.

Curvalaria and Alternaria leat spot : *Curvularia lun* and *Alternaria* sp. cause leafspot diseases. Initially chlorotic sp develop, enlarge rapidly to cover more surface and cause death the leaf. Oxychloride solution 0.3% checks the severity of the ease.

Rust : It is caused by an autocious rust, *Puccinia menthae* affects various mint varieties. It spreads rapidly and causes he damages in herbage yield. Effective fungiciaes are yet to be test however, early harvest and disposal of the debris is more effecti

Diseases of Eucalyptus

a) *Eucalyptus citrodora* Hook. Leaves produce lemon scen oil known as Eucalyptus oil. The herbage contain 0.8 to 1.0% oil, having 65 to 80% citronellal, 15-20% citranellol and its esters. a high valued essential oil and extensively used in beverages food stuffs.

b) *Eucalyptus globulus* Labill, is a temperate tree which attains a height upto 100 m. Leaves contain useful aromatic oil having camphoraceous and pungent taste. It yields 0.9 to 1.2% oil and the oil contains cineole 62%, pinene-24% and aldehydes, ketones and phenols-03%. It is largely used as mosquito repellant, germicidal and applied locally for the treatment of various skin diseases (Anonymous, 1952; Atal, 1982).

Both the Eucalyptus spp. are susceptible to leaf blight disease caused by *Cylindrocladium scoparium* Morg. The disease start appearing in July and August as tiny dark coloured spots. The spots enlarge and coalesces in due course, resulting in drying-up and giving a blightening appearence. Bavistine (0.2%) could check effectively if sprayed at 20 days interval.

Diseases of Ocimum sp.

(a) *Ocimum basilicum* Linn. : It yields 0.5% (fresh w/w) oil which contains methyl cinnamate 56.7%, linalool 4.4%, palmetic acid 7%, stearic acid 0.2%, oleic acid 6.0% and linolenic acid 21%, which is active against gram (+) bacteria and mycobacteria. Leaf extract has antibacterial characters and widely used as mouthwashes, ear ache, etc. (Anonymous, 1966.)

(b) *Ocimum sanctum* Linn.: The leaf distillate yields 0.2 to 0.33% yellow volatile oil with pleasant odour. It largely contains phenols (50-76%). Among them its aldehydes (10-15%) and eugenol (71%) are significant. It is evidently effective against *Mycobacterium tuberculosis*. It is about 1/10 effective than that of streptomycin. It is also a potent mosquito repellant.

Leaves of *Ocimum* spp. are incited by *Cercospora canescens* WL & Mark. It forms irregular to circular spots of dark brown to black colour causing mass defoliation. *Glomerella cingulata* is also responsible for leaf-spot disease. It starts with numerous dark brown spots which coalesce and cause defoliation.

Phyllosticta ocimicola initially, cause spherical to irregular spots on leaf surfaces. In advanced stage it develops into short holes. Bavistin and Benlate were found effective if sprayed in the early stage of the disease development.

Diseases of Lemongrass (*Cymbopogon flexuosus* Linn.)

Because it bears strong lemonlike aroma due to high citra content (75-80%) in the leaves, it is commonly called as Lemon grass It is used in perfumery and cosmetic industries. The oil yield i recorded o.2 to 0.4% (fresh w/w).

Cymbopogon pendulus (Steud) : Its oil contains 75% citral an is used in soap industries. It is also used as a precursor of vitami A (Atal, 1982). Its leaves get infected by a number of leaf-spo causing fungi resulting in heavy defoliation on severity.

Curvularia Blight : It is caused by *Curvularia trifolii* initia ly, it appears in the form of small necrotic lesions which enlarge t form elongated spots along the veins causing death and drying o the leaves. The periodic spray of Dithane M-45 (0.3%) was foun effective in reducing the disease incidence substantially.

Drechslera Blight : *Drechslera holmii* incites the leaves of *pendulus*. The disease starts as small oval chlorotic spots whic enlarge and cover large area resulting the death of leaf. Sulphu dusting or spray of Dithane M-45 (0.3%) was found effective controlling the disease.

Palmarosa

Palmarosa (*Cymbopogon martinii* var. *motia*) is a very usef aromatic grass. It has wide uses in perfumery and cosmetic i dustries (Atal, 1982 & Krishna, 1947). Its leaves contain 0.4 essential oil. During rains the crop gets alarming damage of le spot disease caused by *Curvularia andropogon* is, *C. trifolii* a *Ellisiella caudata*. The periodic spray of Dithane M-45 reduces t incidence of the disease.

Citronella (Java)

Citroenella Java (*Cymbopogon winterianus*) is a hardy crop. has large amount of salt/alkali tolerance and can grow well alkaline soil. Leaves of citronella yield upto 1% oil which is used soap and cosmetic industries.

Curvularia blight : *Curvularia andropogonis* is the caus organism of this disease. The disease appears as elongated reddi brown lesions which coalesce and bring death to entire leaf. T spray of Dithane M-45 (0.3%) at 15 days interval was found effecti to reduce the spread of the disease.

Lethal yellowing : In and around U.P. under excess moisture conditions during July-October the disease appears due to *Pythium aphanidermatum*. The poor, bushy and chlorotic clumps of citronella are easily identify the disease. It is caused due to complete disintegration of vascular tissues of root system. It effects the crop yield to the extent of 31%.

Fields should not be given frequent and excessive irrigation. Pretreatment of Ridomil (0.1%) or Thiram (0.3%) reduces the disease incidence substantially.

CONCLUSION

The results evidently indicated the substantial loss of oil yield due to leaf infections. In frequent cases the yield loss is more than 50%. In economically important plants the extent of loss becomes much more higher. Invariably, the disease initiate or partially degrade the plant cell protein which adversely affects the activity of corresponding enzymes. Hence, the metabolic activity is affected. Predominantly, the alterations in the metabolic activity develop stress conditions to the affected organs and the plant in particular. Thus the synthesis/production or oil is negatively affected.

Thus appropriate plant disease management practices and timely conrol measures (spraying) will check the loss of economic yield and further deterioration of the oil quality.

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STUDIES ON LEGUME INTERCROPPING IN PALMAROSA (*CYMBOPOGON MARTINII* VAR. *MOTIA*)

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ABSTRACT

Field experiments were carried out at the research farm of Central Institute of Medicinal and Aromatic Plants, Lucknow during 1986 to 1988 to maximize productivity and net return per unit area under palmarosa plantation with minimum application of fertilizer N through intercropping of cowpea in *kharif* season (first year) for green manuring and lentil in *rabi* season when the main crop remains dormant for seed production. The treatment comprised of two cropping system (sole cropping and intercropping of palmarosa), two methods of palmarosa planting (regular-row planting at 60 cm and paired-row planting at 45-75-45 cm) and three rates of N (0, 75 and 150 kg N/ha/year) applications.

Intercropping of cowpea (green manure crop) and lentil (seed crop) had no adverse effect on total herb and oil yields (two years cropping cycle) of palmarosa if the intercrops were sown in the space between paired-rows of palmarosa. On the contrary, reduction in palmarosa herb and oil yields were recorded if intercrops were sown in the inter-row space of regular planted crop. Nitrogen application significantly increased herb and oil yields of palmarosa. A positive response was noted upto application of 150 kg N/ha/year for regular planted sole crop of palmarosa; while intercropped palmarosa responded only up to 75 kg N/ha/year. The oil yield of palmarosa in paired-row intercropping treatment sup-

plied with 75 kg N/ha/year was equivalent to that of palmarosa sole crop supplied with 150 kg N/ha/year, suggesting N economy to the extent of 75 kg N/ha/year due to legume intercropping. Furthermore, land utilization efficiency measured in terms of land equivalent ratio and net profitability increased substantially in paired-row intercropping system, compared to palmarosa sole crop system. The possible causes of yield benefits and nitrogen economy are discussed in the light of reduced crop-weed interference and build up of soil fertility.

INTRODUCTION

Palmarosa (*Cymbopogon martinii* var. *motia*), a perennial aromatic grass, is an important essential oil bearing crop of India. Its oil is rich in geraniol (upto 90%) and has high export potential. In north India, raised seedlings are usually transplanted in the main field in the month of July with the onset of south-west monsoon at a spacing of about 60 x 60 or 60 x 45 cm. Being a grass it covers the ground space with the formation of large number of tillers (60-80 per hill), majority of which are formed after first harvest in the month of September. Enough space is, therefore, left unutilised before first harvest causing difficulty in weed management and loss of valuable soil nutrients due to their utilisation by various dominating weed species. In addition to slow initial growth, the crop remains dormant during winter (November-March) in the plains of north India due to low prevailing temperature.

Generally the crop is harvested 3-4 times in a year. Replenishment of nutrients, especially N is essential for continued good crop harvest. The crop requires about 150 kg N/ha/year under north Indian conditions (Sharma *et al.* 1980). Higher nitrogen requirement (240 kg N/ha/year) was, however, reported under south Indian conditions (Prakash Rao *et al.* 1985).

Intercropping of grasses with legumes offers scope for developing sustainable agriculture by more efficiently exploiting environments with limiting or potentially limiting growth resources (Papendick *et al.* 1976). This is because legume as intercrop enriches the soil with biological fixation of atmospheric N. Intercropping of legume may, therefore, substantially reduce fertilizer N requirement of grasses (Patra, 1990). Quantitative benefit or N economy due to intercropping of legume may be as high as 60 kg N/ha

(Akobundu, 1980). Likewise, green manuring is beneficial and may substantially reduce the dependence of a crop on fertilizer N which is a very costly input (Bhardwaj *et al.* 1981). Reduction in N requirement of sugarcane because of green manuring of intercrop of cowpea has been demonstrated (Jothimoorthy *et al.* 1971).

The productivity and efficiency of grass-legume intercrop systems are affected by various agronomic variables like spatial arrangements (Singh, 1981) and N application (Ofori and Stern, 1987). Nonetheless, these aspects have received very little attention, particularly in the context of aromatic grasses. Significant improvement in the efficiency of grass-legume intercrop system was attained also with row arrangement of component crops leading to higher transmission of light to the lower crop (legume) canopy (Mohta and De, 1980).

Therefore, keeping the above in view the present investigation was carried out under conditions of non limiting moisture supply to maximize productivity per unit area under palmarosa plantation with minimum N application through intercropping of cowpea for green manuring after establishment of palmarosa seedlings and lentil for seed production in winter when the main crop (palmarosa) remains dormant.

MATERIAL AND METHODS

Field investigations were carried out during 1986 to 1988 at the Central Institute of Medicinal and Aromatic Plants, Research Farm, Lucknow. The soil of the experimental field was sandy-loam in texture, low in available N (32 mg/kg soil), P (4.5 mg/kg soil) and K (50 mg/kg soil) with pH 8.3 (soil : water ratio 1:2.5). The treatments comprised of two cropping systems (Palmarosa sole crop and palmarosa intercropped with legumes), two methods of palmarosa planting (regular-row planting at 60 cm row spacing and paired row-planting at 45-75-45 cm row spacing) and three rates of nitrogen applications (0, 75 and 150 kg N/ha/year). The experiment was carried out in randomised block design (RBD) with three replications. Individual plot size was 4.8 × 4 m.

Palmarosa (*Cymbopogon martinii* var. *motia*) seeds were sown in the nursery beds (3 × 1·5 m) in the first week of June, 1986. The seedlings were transplanted to main field in the middle of July (rainy season). The row to row spacing was maintained as per

treatment, while plant to plant spacing was kept constant (30 cm). One time P (26 kg P/ha as single super phosphate) and K (50 kg K/ha as muriate of potash) were applied to soil before final land preparation and mixed with the soil of the experimental area. Nitrogen was supplied as per treatments in uniform split doses (after establishment of seedlings and after each harvest during first and second year).

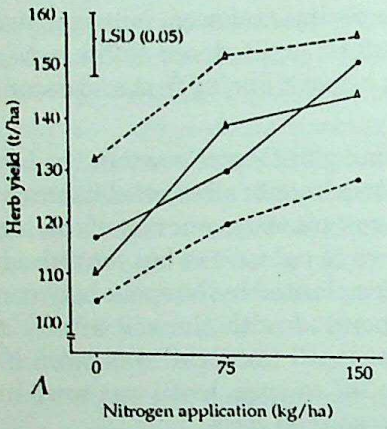
Cowpea fodder seeds (cv. Russian giant) were sown in the last week of July, 1986 in the intercrop treatments after establishment of palmarosa seedlings. For regular-row planting, one row of cowpea was accommodated between two rows of palmarosa but for paired-row planting, two rows of cowpea were planted in the space between pairs. The cowpea crop was incorporated with the soil after six weeks of growth. Similar to cowpea, lentil (cv. local) was sown in October and harvested in March. Unlike cowpea, lentil was sown in both first and second year of palmarosa crop cycle.

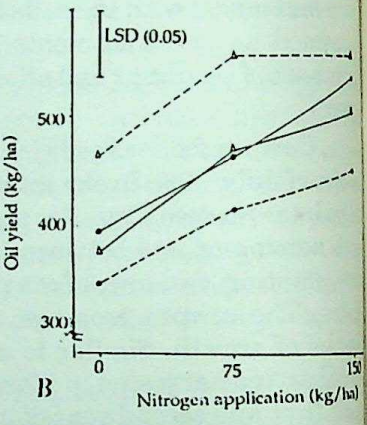
Palmarosa crop was harvested four times (September, November, April and June) in each year. Net area of each plot (leaving one row on each side) was harvested and herb yield was recorded. Oil content was determined in a Clevenger's apparatus, and the oil samples were analysed for geraniol content using Perkin Elmer Model 3920 GLC. Results of oil yield is based on Clevenger reading.

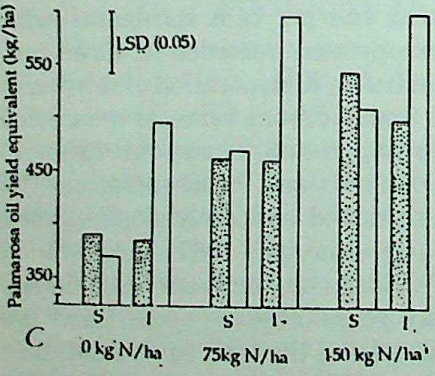
Weed dry matter production and per cent incidental solar radiation intercepted by crop canopy were recorded at three randomly selected points in each plot before incorporation of cowpea in soil. Plant samples of palmarosa from different harvests were dried to constant weight in a hot air oven, ground to pass through a 40 mesh sieve and used for estimation of N and P concentrations (%) by modified micro Kjeldahl method and andomolybdophosphoric yellow colour method, respectively (Jackson, 1967). Available N (Subbiah and Asija, 1956) and P (Olsen and Sommers, 1982) in soil were estimated at the end of two years cropping cycle. Land use efficiency was determined by calculating the land equivalent ratio (LER) as follows (Mead and Willey, 1980) :

$$LER = \sum_{i=1}^{n} (Yi^I/Yi^S$$

where, Yi^I = yield of crop (i) in intercropping, Yi^S = yield of crop (i) in sole cropping and n = total number of crops in the intercropping







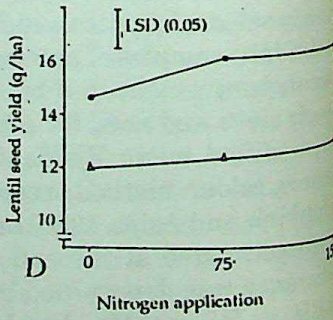


Fig. 1. Palmarosa herb yield (A), oil yield (B), Palmarosa yield equivalent (C) (8 harvest during 1986–88) in sole (——) and intercropping (—) system (• regular; Δ paired row) and lentil yield (D) (total of two years) in intercropping systems (□ regular; □ paired row) with different levels of N application.

system. Lentil crop was sown as sole crop in the border area of the experiment in both years for obtaining sole crop yield.

RESULTS AND DISCUSSION

Intercropping of regular planted palmarosa with cowpea (after establishment of palmarosa seedlings) and lentil (winter season of both first and second year) caused reduction in herb and oil yields of palmarosa, compared to sole crop, particularly when the crop was supplied with 150 kg N/ha/year (Fig. 1A and 1B). Similar yield reduction was, however, not observed when intercropping was done in the space between paired-rows of palmarosa; maximum herb and oil yield were rather recorded in this treatment. The adverse effect of intercropping on regular planted crop of palmarosa was primarily due to low tiller production (data not show), indicating severe competition between companion crops.

Oil yield of palmarosa sole crop planted at regular spacing increased significantly with each increment in N application up to 150 kg N/ha/year. On the contrary, intercropping treatments showed yield advantage only up to 75 kg N/ha/year. Furthermore, palmarosa oil yield in paired-row intercropping treatments supplied with 75 kg N/ha/year was comparable to that of sole crop treatments supplied with 150 kg N/ha/year, suggesting a N economy of 75 N/ha/year due to legume intercropping in paired-row planted palmarosa. Similarly, soybean green manure intercrop resulted in significantly larger maize yields than when maize was grown without green manure and provided an additional yield equivalent of 28 kg N/ha on the zero nitrogen plots (Pandey and Pandleton, 1986). The higher N economy in the present study may be attributed to intercropping of palmarosa with both cowpea green manure crop and lentil seed crop. In addition, there may be temperature effects. According to Singh and Jha (1984) and Bandyopadhyay and De (1986) the effect of extreme temperatures could be reduced by intercropping with compatible crops and row arrangements or by intercropping crops that do not compete with each other for environmental resources. The relative increase in Palmarosa herb and oil yield due to intercropping was higher in winter (April) harvest, compared to other harvests and this may be attributed to temperature effects. In addition, paired-row intercropping treatments produced 12-16 q/ha of additional lentil seed in two years (Fig. 1D). The lentil seed yield was lower in paired-row intercropping compared to regular inter-

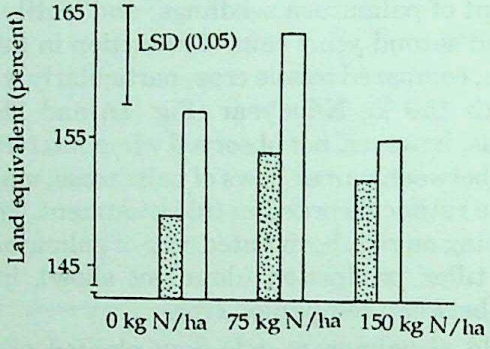


Fig. 2. Land equivalent ratio in regular (□) and paired-row (□) intercropping systems with different levels of N application.

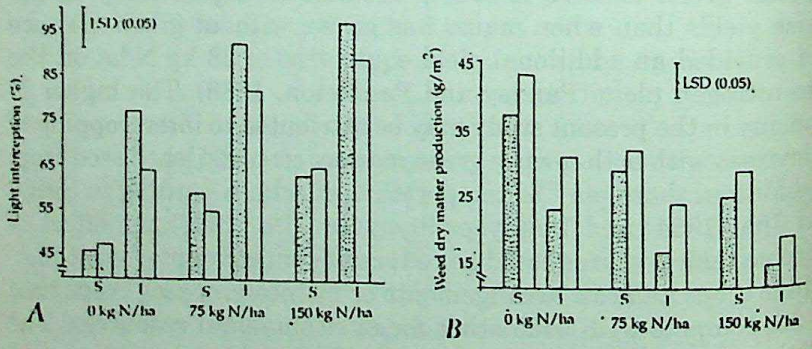


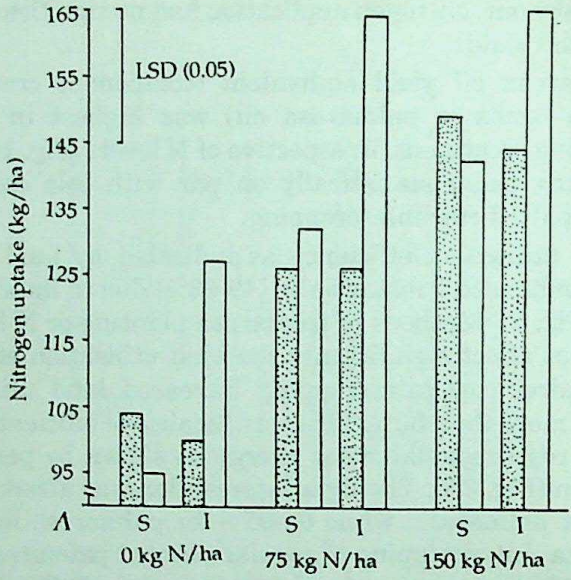
Fig. 3. Light interception (A) and weed dry matter yield (B) before incorporation of cowpea in soil in sole (S) and intercropping (I) systems (□ regular; □ paired row) with different levels of N application

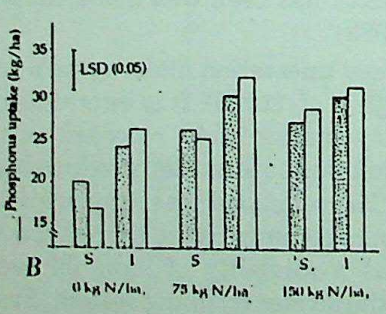
cropping due to reduction in proportionate space under lentil in the former treatment. Nitrogen application had no significant influence on lentil seed yield.

Palmarosa oil yield equivalent (component crop yield expressed in terms of palmarosa oil) was highest in paired-row intercropping treatment, irrespective of N levels (Fig. 1C). Regular intercropping being statistically on par with sole cropping was inferior to paired-row intercropping.

Land utilisation efficiency as indicated by land equivalent ratio was enhanced substantially (49-63%) due to intercropping of legumes (Fig. 2). Methods of palmarosa planting or N levels, however, did not affect significantly the land utilisation efficiency. In general, paired-row intercropping increased land utilisation efficiency by more than 50%. This was because of efficient utilisation of natural resources like solar energy as shown by per cent light interception (Fig. 3A). The light interception was about 45-65% for sole crop of palmarosa, while 65-95% for palmarosa intercropped with cowpea. Intercropping of regular planted palmarosa supplied with 75 or 150 kg/ha/year caused very little light (3-8% of incidental radiation) to reach the ground surface, compared to 10-18% of incidental rediation reaching ground surface in paired-row intercropping. Availability of less light on the ground surface might be responsible for reduction in tiller number per unit area in regular intercropping, compared to paired-row intercropping. Reduction in tillering due to reduced light intesity has been well demonstrated in other grass species (Francis, 1989)

Intercropping may reduce weed infestation under certain conditions as has been shown by Singh *et al.* (1986). It is interesting to note that in this study weed dry matter yield recorded before incorporation of cowpea into the soil was substantially reduced as a result of intercropping (Fig. 3B). The reduction was comparatively much higher in regular intercropping, compared to paired-row intercropping. This was obvious as availability of light for weed growth was comparatively less in the former cropping system (Francis 1989). The weed dry matter yield was negatively correlated ($r = -0.71$) with nitrogen application. The removal of weeds irrespective of treatments (general weeding) after establishment of palmarosa might be responsible for this negative relationship. Nitrogen application promoted palmarosa crop growth which in turn indirectly





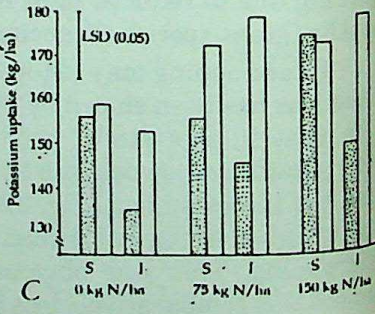


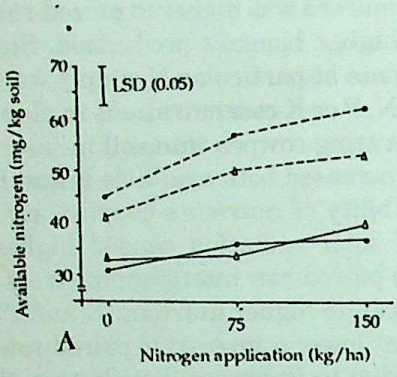
Fig. 4. Nitrogen (A), phosphorus (B) and potassium (C) uptake by palmarosa in two years cropping under sole (S) and intercropping (I) systems (□ regular; □ paired row) with different levels of N application

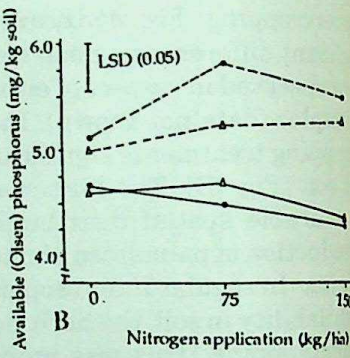
provided little opportunity for the weeds to grow after the general weeding.

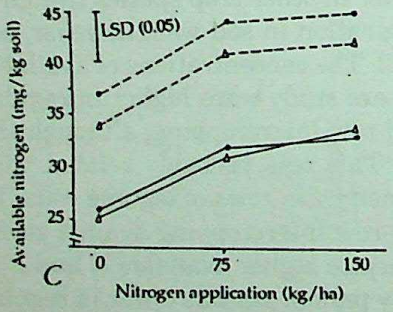
The uptake of N, P or K by palmarosa was higher in paired-row intercropping (Fig. 4) because of higher biomass production. Significant differences among treatments at particular N supply were not observed in respect of either of N, P or K concentrations in plant samples (data not shown). Incorporating cowpea into soil in intercropping treatments significantly increased both available N and P in soil (Fig. 5I). The higher availability of nutrients coupled with favourable spatial distribution of solar radiation caused higher production of palmarosa biomass in paired-row intercropping treatments. In regular inter cropping, despite higher nutrient (N and P) availability in soil, the herb yield was lower compared to paired-row intercropping. This was probably due to improper distribution of solar radiation in the former intercropping situation. The planting geometry of palmarosa sole crop, however, did not influence the concentrations of available N or P in soil.

Intercropping substantially increased the amount of available N left in the soil after completion of two years cropping cycle (Fig. 5IIA). Thus, in addition to yield advantages and N economy to the tune of 75 kg N/ha/year, paired-row intercropping also improved soil fertility. Similar beneficial effect of legume intercropping on soil N content has also been shown earlier in other crop species (Singh *et al.* 1986). The available P concentration in soil was, however, not significantly influenced (Fig. 5IIB). The concentrations of available N or P after completion of two years study were higher in regular intercropping compared to paired-row intercropping, although the differences were not significant. This was probably related with intercrop (legume) population density. Six rows of legume could be accommodated per plot in paired-row intercropping against seven rows in regular intercropping. Despite higher available N and P in soil, the uptake of both N and P by palmarosa was lower in regular intercropping than paired-row intercropping. This suggests probable limitation of other growth factor e.g., solar radiation for non performance of treatments of regular intercropping.

Calculated net return from two years palmarosa cropping as influenced by various treatments are shown in Fig. 6. Highest net return was recorded with paired-row intercropping treatment sup-







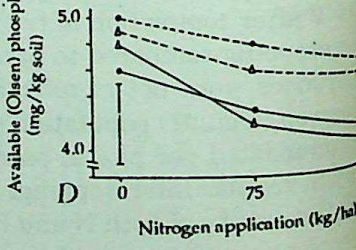


Fig. 5. Available nitrogen (A) and phosphorus (B) in soil (0–15 cm) I. Aft incorporation of cowpea into soil and II. After completion of two years croppin under sole (——) and intercropping (—) systems (• regular; Δ paired-rows) wit different levels of N application

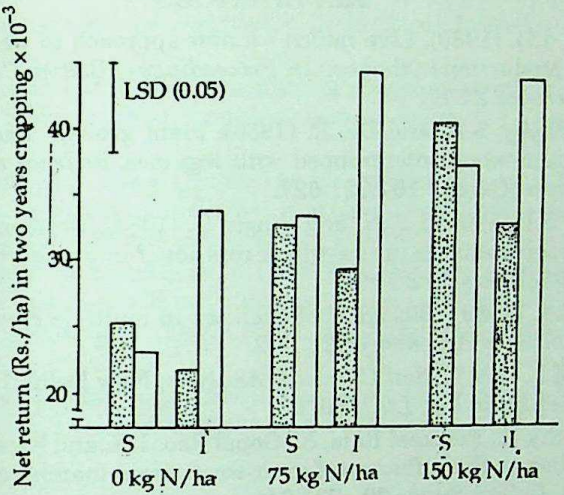


Fig.6. Net return from two years cropping as influenced by sole (I) and intercropping (1) system (■ regular; □ paired-row) with different levels of N application

plied with 75 kg N/ha/year. Application of N beyond 75 kg N/ha/year in intercropping treatments did not influence net return further.

In conclusion, intercropping of legumes in paired-row planted palmarosa showed substantial yield advantage, higher land use efficiency and net income. This was due primarily to greater light utilization and acquisition of N and P and lower incidence of weeds compared with pure stands of palmarosa. In addition to yield advantage, intercropping may substantially minimise N requirement (75 kg/ha/year) of palmarosa grass. The results of these analyses provides some quantitative evidence for the widely held notion that a greater total uptake of nutrient and light utilisation by component crops and lower weed incidence in grass/legume intercropping are the primary cause of yield advantage. Furthermore, in contrast to sole cropping, inter-cropping causes less depletion of soil in respect of available nutrients. Thus, under conditions of non limiting moisture supply, the practice of growing legumes in palmarosa is a viable alternative to replace a part of the fertilizer N requirement, particularly for small farmers.

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EFFECT OF N, P AND K APPLIED THROUGH SOIL FERTILIZATION AND FOLIAR SPRAYS ON THE FLOWER YIELD OF *ROSA DAMASCENA* MILL. GROWN ON SODIC SOILS.

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ABSTRACT

A two years study was conducted on *Rosa damascena* Mill. at Research Station Banthra of the National Botanical Research Institute, Lucknow during 1978 to 1980 on sodic soils. Results indicated that soil applications of 150 kg. N in the form of ammonium sulphate, 75 kg. P_2O_5 in the form of single superphosphate, 60 kg. k_2O in the form of muriate of potash; and 1% urea, 0.3% orthophosphoric acid, 0.2% potassium citrate as foliar spray were the optimum doses for maximum flower production.

INTRODUCTION

Rosa damascena Mill. which is commonly known as Damask rose or chaiti gulab, is one of the important perfumery rose. It is commercially cultivated in our country, previous experiments conducted by the author (Srivastava, 1975) at Research Station Banthra (RSB) of National Botanical Research Institute (NBRI), Lucknow; and by Singh *et al.* (1962) at HBTI, Kanpur had shown increased flower yield by the application of nitrogen (N) to this crop. Also, the macro/fertilizer elements (N,P and K) have been reported to be major nutrients for successful production of several crops grown in India. Hence the study of their effects on this perfumery rose is important for improving the flower yield.

Therefore, a series of experiments were conducted during 1978 to 1980 at RSB of NBRI on sodic soils (pH 8-9). Six experiments were laid out in a randomized block design with four replications. The treatments were as under :-

Series I - N, P and K singly through soil application.

Doses of N = 0, 50, 75, 100, 125 and 150 kg. per hectare (ha.) as ammonium sulphate (AS)

Doses of P = 0, 25, 50, 75, 100 and 125 kg. P_2O_5 per ha. single superphosphate (SSP).

Doses of K = 0, 20, 40, 60, 80 and 100 kg. k_2O per ha. as muriate of potash (MOP).

Series II - N, P and K singly through foliar application.

Doses of N = 0, 0.5, 1.0, 1.5, 2.0 and 2.5% of urea solution.

Doses of P = 0, 0.10, 0.15, 0.20, 0.25 and 0.30%s of orthophosphoric acid solution (OPA)

Doses of K = 0, 0.10, 0.15, 0.20, 0.25, and 0.30%s of potassium citrate (KC) solution.

A basal dose of well rotten cowdung manure was applied just after prunning in the first week of January each year. 0.1% Teepol was used in the above spray solutions as wetting agent/spreader. The plants were sprayed six times at an interval of 10 days commencing from 10th January each year. Results are presented in tables from 1 to 6. In all the tables the flower yield has been given in quintals (Q) per ha.

SERIES I

TABLE 1 - Effect of N

Doses of N in Kg per ha.	1978-79 (Flower yield)	1979-80 (Flower yield)	Mean of the two years
0	8.40	10.39	9.40
50	16.82	18.78	17.80
75	17.80	20.38	19.09
100	18.63	20.65	19.64
125	20.82	22.33	21.57
150	24.22	24.49	24.36
SEm ±	0.7583	0.6144	0.6901
CD 5%	2.28	1.85	1.91

TABLE 2 - Effect of P

Doses of P_2O_5 in kg per ha	1978-79 (Flower yield)	1979-80 (Flower yield)	Mean of the two years
0	13.42	14.53	13.98
25	19.97	19.70	19.84
50	21.15	21.39	21.27
75	24.93	22.10	23.52
100	20.17	20.25	20.21
125	19.81	21.34	20.58
SEm ±	0.9578	0.5831	0.7914
CD 5%	2.89	1.75	2.19

TABLE 3 - Effect of K

Doses of K_2O in Kg. per ha	1978-79 (Flower yield)	1979-80 (Flower yield)	Mean of the two years
0	13.45	14.61	14.03
20	16.27	18.22	17.33
40	19.35	20.52	19.94
60	26.54	24.46	25.50
80	25.09	22.39	23.74
100	20.07	20.32	20.20
SEm ±	0.5659	0.8944	0.7475
CD 5%	1.70	2.69	2.07

SERIES II

TABLE 4 - Effect of N

Doses of N as urea solution	1978-79 (Flower yield)	1979-80 (Flower yield)	Mean of the two years
0	18.48	17.07	17.78
0.5%	21.07	19.39	20.23
1.0%	28.79	27.57	28.18
1.5%	26.73	25.11	25.92
2.0%	22.82	20.21	21.52
2.5%	17.58	19.81	18.68
S Em ±	0.6964	0.4031	0.5690
CD 5%	2.11	1.21	1.58

TABLE 5 - Effect of P

Doses of as OPA solution	1978-79 (Flower yield)	1979-80 (Flower yield)	Mean of the two years
0	14.00	16.04	15.02
0.10%	16.00	16.12	16.06
0.15%	16.55	18.39	17.47
0.20%	19.89	19.63	19.76
0.25%	21.90	20.64	21.27
0.30%	26.01	24.13	25.07
SEm ±	0.9165	0.6708	0.8047
CD 5%	2.77	2.02	2.23

TABLE 6 - Effect of K

Doses of K as KC spray	1978-79 (Flower yield)	1979-80 (Flower yield)	Mean of the two years
0	11.39	12.90	12.15
0.10%	15.20	13.40	14.30
0.15%	17.84	13.61	15.73
0.20%	21.04	18.75	19.90
0.25%	19.74	15.79	17.77
0.30%	16.66	10.85	13.76
S Em±	0.7124	0.7000	0.7062
CD 5%	2.15	2.11	1.96

The data presented in tables 1 to 6 shows that application of N, P and K either through soil or foliar sprays, improves the flower yield of Damask rose, when applied singly without the use of the other two fertilizer elements. No significant differences in yield being obtained within the years. Considering the mean of the data of the two years given in the above tables, the following conclusions could be drawn. N, when applied through soil, gave significant increase in flower yield at the highest level (150 kg. N per ha.) over the other treatments; while foliar applications of urea sprays at 1% gave significantly higher yields over the other treatments.

Similarly, in case of P, when it is applied through soil, significant increase in the flower yield was obtained at an application rate of 75 kg. P_2O_5 per ha., whereas at higher levels of applications, there was significant reduction in yield; and when applied through

foliar sprays of OPA solution, an increasing trend in yield was indicated at the highest level of 0.3%.

Further, in the case of K, when it is applied through soil, significant increase in flower yield was obtained at an application level (60 kg. K_2O per ha.), whereas higher levels of potash applications giving reduced yield; while applications through KC sprays, significant increase in flower yield was obtained on application level of 0.2%, thereafter decreases were observed at the higher levels.

In this way, from these preliminary experiments, it may be concluded that the fertilizer elements increase the flower yield. 80 kg. P_2O_5 in the form of SSP, 60 kg. K_2O in the form of MOP, 1% urea, and 0.20% KC sprays; are the optimum doses for maximum flower production in Damask rose. In the case of N through soil and of OPA sprays the maximum flower production is obtained at 150 kg. and at 0.30% respectively, but these levels are not the optimum because, further increase in flower yield is possible at higher levels. Considering these facts and that no response of the combined effects of these fertilizer elements could be known by these experiments; further investigations were planned to study the effect of macro-elements in combination with each other on the flower yield and other vegetative and floral characters.

The author is grateful to the Director, NBRI for facilities.

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STUDIES ON THE EFFECT OF NPK APPLICATION ON THE VEGETATIVE AND FLORAL GROWTHS OF *ROSA DAMASCENA* MILL. GROWN ON SODIC SOILS.

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ABSTRACT

The studies on the use of N, P and K in its various combinations were undertaken. These elements were applied to the rose plants through soil as well as through foliar sprays. Results showed that irrespective of the mode of application, the vegetative and floral growths were greatly influenced. Growths obtained through soil are superior as compared to foliar application. Lighter flowers in greater numbers are borne with foliar application, but the flower yield is more in the soil application. The combination of 150 : 80 : 60 for N, P and K respectively in soil application gave maximum flower yield of 26.5 quintals (Q) per ha as compared to control (11.25 Q per ha), while with foliar application the combination of 1.0% urea, 0.3% Orthophosphoric acid and 0.2% potassium citrate gave maximum flower yield of 23.35 Q per ha as compared to 11.35 Q in control.

INTRODUCTION

The fertilizer elements N, P and K singly and in combination used in soil and as foliar sprays play an important role in enhancing vegetative/floral growths in plants (Heatley, 1959 : Pal, 1964 : Tandon, 1972). Though work had been done in other crops, not much work on this aspect has been reported on *Rosa demascena*. The author also conducted several nutritional experiments at Research

Station Banthra (RSB) of National Botanical Research Institute, Lucknow (NBRI), and published (Srivastava, 1975) / unpublished, which also revealed that N, P and K increase the flower yield.

Considering these facts, the present investigations were undertaken.

MATERIAL AND METHOD

The experiments were conducted during 1981-82 and 1982-83 in a randomized block design with a factorial concept. The details of the doses of N, P and K taken with their treatment combinations are given at the end of table 1. Observations of the vegetative and floral growths as compared to control were taken. The growth obtained in control and the max growth (at their optimum doses) are given in Table 1 for comparision.

The fertilizers were applied to the soil as under : Half the dose of N, entire quantity of P + K were applied just after pruning the crop in the first week of January each year. The remaining half of N was applied 30 days after the first application. N was applied in the form of ammonium sulphate (AS), P in the form of single superphosphate (SSP) and K in the form of muriate of potash (MOP). AS and MOP were applied as top dressing, while SSP was applied at a depth of 5 cm in a ring around the plants.

In the foliar spray trial, 0.1% Teepol was used as wetting agent/spreader. In the spray solutions, urea, Ortho-phosphoric acid (OPA) and potassium citrate (KC) were used to supplement N, P and K respectively to the plants. In OPA solution NaOH (0.1 N) was added to maintain the pH around/above 6. Spraying was done at an interval of 10 days, commencing from the 10th January each year; the crop being sprayed six times according to the treatments.

Table : Effect of NPK application through soil and foliar sprays on vegetative and floral characters.

Attributes	Soil application		Foliar application	
	Control	Maximum growth under treatment combination	Control	Maximum growth under treatment combination
A. Vegetative Characters				
1. Spread of a plant (M)	0.93	$N_3P_2K_2$(1.34)	0.90	$N_6P_5K_5$(1.28)
2. Height of a plant (M)	1.02	-do-(1.40)	1.02	-do-(1.33)
3. Number of vegetative shoots in a plant	13.76	-do-(21.20)	13.32	-do-(18.85)
4. Length of a vegetative shoot (cm)	51.25	-do-(72.22)	50.01	-do-(69.06)
5. Number of internodes in a vegetative shoot	4.58	$N_3P_3K_2$(7.27)	4.58	$N_6P_6K_5$(7.34)
6. Weight of pruned material per plant (kg)	0.937	$N_3P_2K_2$ (1.970)	0.953	$N_6P_5K_5$ (1.897)
B. Floral Characters				
1. Time taken to flower (days)	68.56	$N_3P_3K_1$ (72.52)	68.59	$N_6P_6K_4$ (73.38)
(a) Longest			68.59	$N_4P_4K_6$ (67.48)
(b) Shortest	68.56	$N_1P_1K_3$ (67.24)		
2. Duration of flowering (days)	46.17	$N_2P_2K_2$ (56.22)	41.17	$N_5P_5K_5$ (51.34)
3. Weight of a flower (g)	2.42	-do-(3.64)	2.39	-do-(3.40)
4. Size of a flower (cm)	4.70	-do-(6.17)	4.66	-do-(5.87)
5. Number of petals in a flower	37.48	-do-(48.22)	37.73	-do-(48.17)
6. Corolla/calyx ratio (CCR)	2.86	-do-(4.11)	2.81	-do-(3.98)
7. Number of floral twigs in a plant	6.36	-do-(7.81)	6.23	-do-(7.36)
8. Number of flowers in a floral twig	8.16	-do-(10.30)	8.46	-do-(10.37)

	Attributes	Soil application		Foliar application	
		Control	Maximum growth under treatment combination	Control	Maximum growth under treatment combination
9.	Number of flowers in a plant	51.76	$N_2P_2K_2$ (79.93)	52.58	$N_5P_5K_5$ (76.32)
10.	Concrete % in flowers	0.177	$N_2P_3K_2$ (0.226)	0.17	$N_5P_6K_5$ (0.224)
11.	Yield of flowers per hectare (Q)	11.25	$N_2P_2K_2$ (26.52)	11.35	$N_5P_5K_5$ (23.35)

N_1 = 75 kg N per hectare (ha)
N_2 = 150 kg N per ha
N_3 = 225 kg N per ha
P_1 = 40 kg P_2O_5 per ha
P_2 = 80 kg P_2O_5 per ha
P_3 = 120 kg P_2O_5 per ha
K_1 = 30 kg K_2O per ha
K_2 = 60 kg K_2O per ha
K_3 = 90 kg K_2O per ha
M = meter/meters+
cm = centimeter/centimeters+
kg = kilogramme/kilogrammes+
Q = quintal/quintals+
g = gramme/grammes+

N_4 = 0.5% urea
N_5 = 1.0% urea
N_6 = 1.5% urea
P_4 = 0.15% OPA
P_5 = 0.30% OPA
P_6 = 0.45% OPA
K_4 = 0.1% KC
K_5 = 0.2% KC
K_6 = 0.3% KC

RESULTS AND DISCUSSION

The data on various attributes obtained in different treatment combinations, were compiled in different tables and were statistically analysed. It was observed that almost in all the treatment combinations (except time taken to flower), the minimum growths obtained was in control i.e. $N_oP_oK_o$; and in majority of the treatment combinations, the growths were significantly higher than the control, and there were significant differences between the treatment means of individual attributes. As it is not possible to give details about all the data, maximum growths obtained in different treatment combinations has been given in the table 1.

The results indicate that the vegetative and floral growths are minimum at control, then gradually rise to maximum at a definite (optimum) level of combination.

The data given in table 1 reveals that the maximum growths in different attributes are the results of the application of NPK combinations to the rose plants at their optimum levels. It may also be concluded that vegetative and floral growths are greatly influenced by the application of NPK combination by both soil and foliar feeding as compared to control. Maximum growths in the vegetative characters are obtained by the higher level of $N(N_3)$ plus middle level of $P(P_2)$ plus middle level of $K(K_3)$; except in number of internodes where the maximum number is obtained by the higher level of $N(N_3)$ plus higher level of $P(P_3)$ plus middle level of $K(K_2)$, in both the experiments. Further, maximum growths in floral characters, number of flowers per plant and yield of flowers are obtained by the middle levels each of $N(N_2)$ plus $P(P_2)$ plus $k(k_2)$ whereas, maximum concrete percent is obtained by the middle level of $N(N_2)$ plus higher level of $P(P_3)$ plus middle level of $K(K_2)$.

Vegetative and floral growths were better in soil feeding than the foliar feeding. But the results of the foliar feeding compares well with the feeding through soil, confirming the idea that the application of plant nutrients through foliar sprays are supplement to soil application. Although the soil feeding is better but feeding through foliar sprays are beneficial, when the soil is alkaline, fixes soil applied nutrients into non-available forms more readily, propping the utility of the present investigations conducted.

N is responsible for synthesis of aminoacids in plants, while P plays an important role/part in cell division, encourages root development, hastens leaf development. K is responsible for metabolic activities, imparts increased vigour in plants.

The higher growth of vegetative and floral attributes by the application of these elements is due to the higher rate of photosynthesis and increased physiological activities in the Damask rose plants, which is due to the reasons mentioned in the preceding para. The experiments conducted at RSB by the author (Srivastava, 1975) and at HBTI Kanpur by Singh *et al.* (1962) also showed increased floral growths due to these reasons and confirms the results of the present investigation.

The author is grateful to the Director NBRI for facilities.

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DEVELOPMENT IN TECHNOLOGY OF PRODUCTION OF ESSENTIAL OILS

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ABSTRACT

A large number of process parameters affect the yield and quality of essential oil produced by the process of distillation. A knowledge of these parameters and their influence on yield and quality is important for every producer of essential oils. Role of process variables like mode of distillation, steam pressure, material of construction of plant, steam injection rate, distillation, time steam distribution and condition of raw material is discussed. Essential features of a boiler operated plant *vis-a-vis* directly fired field distillation unit are presented. New developments like continuous steam distillation are discussed.

INTRODUCTION

With increasing preference for natural raw materials in world fragrance industry, Indian essential oils have the potential of becoming a major export item. In order to compete in the international market, the quality of essential oils have to be of a very high order. Steam distillation is the main technology employed for production of essential oils, and knowledge of important process parameters which affect the yield and quality of essential oils is very useful.

(1) Mode of Distillation

Apart from steam distillation, hydrodistillation and water & steam distillation are also employed for production of essential oils (Kahol, 1989). In hydrodistillation, the plant raw material is completely immersed in water, and in water & steam distillation, the

raw material is placed on a grid and steam is generated in a water tank below the grid, like in a field distillation unit. Table-1 shows the yield of essential oils obtained from the same plant raw material when processed by different modes of distillation.

TABLE : 1 Effect of Mode of distillation on yield of oil

Raw Material	Yield of essential oil (%)		
	Hydro-Dist.	Water & Steam Distillation	Steam Distillation
Vetiver Roots	0.08	0.2	0.13
Nagarmotha 0.20	0.32	0.41	
Celery Seed	1.35	–	0.80
Cedarwood	3.7	–	4.40

Data obtained at CIMAP Pilot Plant

From the data presented in TABLE-1, it is evident that it is necessary to adopt the suitable mode of distillation for obtaining optimum yield of an essential oil. Selection of optimum mode of distillation is best made by conducting pilot plant scale trails.

(2) Size of Raw Material

Raw material size can significantly affect the yield of oil as the bed porosity and steam distribution are altered by chopping or powdering a plant raw material. Table-2 presents pilot plant data for distillation trials conducted on some common essential oils (Kahol *et al.* 1986 and 1988).

TABLE : 2 Effect of raw material size on yield of essential oil.

S.No.	Raw Material	Size	% oil yield
1.	Palmarosa	Whole herb	0.49
2.	-do-	Chopped	0.55
3.	Mentha piperita	Whole herb	0.47
4.	-do-	Chopped	0.44
5.	Nagarmotha	Whole herb	0.08
6.	-do-	(-6) Mesh	0.40
7.	-do-	(-12) Mesh	0.35
8.	Lemongrass	Whole herb	0.33
9.	-do-	Chopped	0.34

It may be noted from data in TABLE-2 that chopping and powdering of raw material may not always result in higher oil yield. Also the cost of energy required in size reduction has to be balanced against increased yield oil.

(3) Effect of Steam Pressure

The temperature of steam employed for distillation depends on its pressure in the boiler. From the thermodynamic data, the temperature variation of steam with pressure is as follows :

Steam Pressure (PS IG)	Temperature (°C)
0	100
30	134
60	153
105	171
235	204

Steam pressure influences the yield of oil (Aggarwal *et al.* 1973) evident from data presented in TABLE-3. For any duty the use of lowest pressure which can do the job is indicated by economic consideration.

TABLE-3 : Effect of steam pressure on yield of essential oil

RAW Material	Steam Pressure (PSGI)	Oil %
Cedarwood	19	4.18
-do-	34	4.41
-do-	50	3.67
Nagarmotha	0	0.32
-do-	20-25	0.50
-do-	40-45	0.48

(4) Condition of Raw Material

Condition of raw material, whether fresh or wilted can significantly affect the yield of essential oil. Drying of freshly harvested herb in shade reduces its moisture content thereby facilitating distillation and reducing steam consumption. Data on distillation of *Mentha arvensis* herb dried in shade as well as sun is presented in TABLE-4. (Hazra *et al.* 1990)

TABLE- 4 : Effect of drying of *Mentha arvensis* herb

Period of Drying (DAYS)	Shade drying		Sun drying	
	% Moisture	Oil %	% Moisture	Oil %
0	69.0	0.84	69.0	0.84
1	46.5	0.88	29.5	0.84
2	23.3	0.90	15.3	0.81
3	18.5	0.84	6.85	0.80
4	12.5	0.83	3.5	0.79
5	8.5	0.81	1.0	0.75
6	6.0	0.80	Nil	0.70
7	4.0	0.79	Nil	0.66

It may be noted that dyring of mentha herb in shade for two days is quite beneficial as oil yield is enhannced by about 4.5% and consumption of steam during distillation is reduced substantially. But this recommendation may not be applicable to all plant raw materials and every case should be examined by pilot plant trials.

(5) Steam Injection Rate

The rate at which steam is injected into the plant material bed in the distillation tank can markedly influence the recovery of essential oil. The point is illustrated by experimental data on cedarwood distillation which is presented in Table-5 (Aggrwal *et al.* 1973).

TABLE-5 : Effect of steam injection rate on oil yield of cedarwood powder.

Quantity of cedarwood in each batch = 750 kg.

Steam rate (kg/hr.)	% Yield of Oil
180	6.3
210	6.8
240	7.3
270	7.7
300	7.4

(6) Boiler Operated Unit Vs Directly Fired Type

Directly fired field distillation units (FDU), where in the steam is generated inside the distillation tank itself, are attaining wide popularity (Kahol, 1989). As compared to expensive boiler operated units, FDU is lower in capital cost and simple to operate. Following points should be kept in mind while choosing between boiler operated unit and FDU.

(a) It is possible to run a large number of distillation units by a single steam boiler. Hence a boiler operated system is ideal for large scale production of essential oils. FDU is more suited for small and medium farmers.

(b) The efficiency of extraction of essential oil in a well designed FDU can equal that obtained by a boiler unit. But in a poorly designed FDU oil recovery may be low and fuel wastage may be heavy accompanied by smoke pollution.

(c) Steam injection rate in a boiler operated unit can be adjusted with ease but steam generation rate in FDU is limited by heat transfer area provided in the unit. Insufficient steam generation in a FDU can result in low oil yield. Designs of efficient FDU with high steam generation rate are available at CIMAP.

(d) Boiler operated unit requires a skilled boilerman for operation but FDU can be operated by relatively low skilled workers.

(e) Designs of boiler operated units and FDU are available which can burn distilled plant material as fuel after drying.

(7) Continuous Distillation Plant

Batch type distillation plants are highly labour intensive as charging and discharging of plant material to distillation tank has to be done manually. Discontinuous operation also results in plant being idle between two batches. Continuous distillation plants are known to be operating in U.S.S.R. for distillation of mint, lavender and clarysage. Performance of a continuous plant for distillation of Cedarwood oil has recently been reported from Texas, U.S.A. (Baucard *et al.* 1991)

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ANTI FUNGAL SUBSTANCE IN THE ESSENTIAL OIL OF CUMIN (*CUMINUM CYMINUM* L.)

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ABSTRACT

Cumin, an important seed spice, is mainly affected by a wilt which is caused by a fungus, *Fusarium oxysporum* f. sp. *cumini*. The range of essential oil extracted from different entries of cumin varied from 2.73% to 4.86%. The maximum essential oil was determined in UC-198 (4.86%) followed by UC-199 (3.93%). The essential oil of cumin caused inhibition of Fusarium growth. The effectiveness followed the sequence : UC-199 > UC-198 > Local > UC-19 > UC > UC-89 > RS-1 control. The essential oil from coriander and fennel were not inhibitory to the growth of fungus.

INTRODUCTION

Essentials oils have been used in many different applications like insect repellant, disinfectants etc. The essential oils of several higher plants have shown success in plant disease control, and are harmless and non-phytotoxic unlike synthetic pesticides (Bhargava *et al.*, 1981; Dubey *et al.*, 1983). The mycelial growth of several phytopathogenic and saprophytic fungi is inhibited by essential oil (Singh and Dwivedi, 1957). Shukla and Tripathi (1987) reported an antifungal substance from essential oil of anise. The antifungal activity of essential oil from palmarosa leaf, seed of aniseed and vetiver roots were shown against different fungi by Gangradel et al. (1991). In this paper, an anti-fungal substance present in essential

oil of cumin (*Cuminum cyminum* L.) against wilt pathogen, *Fusarium oxysporum* is reported.

MATERIALS AND METHODS

Seeds of different selected entries of cumin were collected from experimental plots of all India Co-ordinated Spices Improvement Project, Jobner which included entries from different states. 100 g seeds of each entry was separately ground in blender and subjected to hydro-distillation by using clevenger apparatus (Guenther, 1955). Essential oil thus obtained was separated and collected in a glass vial for further use. Oil sample was made moisture free by using anhydrous sodium sulphate.

Culture

Fusarium oxysporum f. sp. *cumini*, a causative agent of cumin wilt syndrome, was isolated from the infected vascular track of cumin roots. It was identified and confirmed by IMI, Kew, U.K. (IMI No. 294847).

Diffusion assay method

Antagonistic effect of essential oil was examined using diffusion assay method on potato-dextrose agar medium at 28°C. Antagonism was studied against isolates of test fungi by placing the test fungi in the centre and essential oil (one loop) at the periphery of the petriplate, 3 cm apart from the centre of the dish. The growth of the fungus was measured as width of the fungus. The per cent inhibition of growth was calculated using control plate as 100% fungal growth or no inhibition. The treatments were replicated thrice and each replication consisted of a single petridish.

RESULTED AND DISCUSSION

Certain oils are produced by plants as toxins against disease so they may also be involved in protection of plants from pathogens. Antimicrobial property of essential oils have been reported by many workers (Shukla and Tripathi, 1987; Grover and Rao, 1987; Chaumont and Bardey, 1989; Thomas, 1989; Sinha and Gulati, 1990). The essential oil extracted from different entries of cumin ranged from 2.73% to 4.86% (Table 1). The entries having more oil contents were found to be more resistant against wilt, but this may not always be correct.

Table 1. Essential oil content of selected entries of cumin seed (*Cuminum cyminum* L.)

S. No.	Accession number	Essential oil content (%)			
		1989–90	1990–91	1991–92	Mean
1.	UC-198	4.8	4.6	5.2	4.86
2.	UC-199	3.4	4.0	4.4	3.93
3.	UC-218	3.5	4.05	3.6	3.71
4.	UC-89	3.3	4.05	3.5	3.61
5.	Local	2.9	3.85	3.2	3.31
6.	RS-1	3.0	3.8	2.7	3.16
7.	UC-19	2.9	3.7	2.6	3.06
8.	UC-209	2.3	3.3	2.8	2.80
9.	UC-208	2.6	3.1	2.5	2.73

Two strains of *F. oxysporum* f. sp. *cumini* were isolated. Antifungal activity of essential oil from different entries were evaluated against these two strains of *F. oxysporum* (Table 2). The effectiveness of essential oil against these strains followed the following sequence:

Table 2. Effect of essential oil from cumin on growth of *Fusarium oxysporum* f. sp. *cumini* at 28 ± 1°C after 6 days incubation.

Accession No.	% fungal growth inhibition	
	Strain I	Strain II
Control (check)	No inhibition	No inhibition
Cumin		
UC-199	100	100
UC-198	100	100
Local	75	44
UC-89	54	31
UC-19	47	39
RS-1	8	41

For strains I

UC-199 UC-198 Local UC-19 UC-89 RS-1

For strain II

UC-199 UC-198 Local RS-1 UC-19 UC-89

Farag *et al.* (1989) determined the basic components from essential oil of thyme leaves, cumin fruit, clove flower bud, caraway fruit, rosemary leaves and sage leaves. The antifungal activity and inhibition of aflatoxin production of the oil against *Aspergillus parasiticus* was maximum in thyme leaves followed by cumin fruit. Singh and Upadhaya (1991) reported that cuminaldehyde, the main constituent of cumin seed oil, showed fungitoxic activity against *A. flavus* and *A. niger*. In this study essential oil from UC-199 and UC-198 showed good degree of antifungal activity as compared to RS-1, which is a susceptible variety. This indicates that proportion of antifungal substance in UC-199 and UC-198 are higher as compared to RS-1. 100% fungal growth inhibition was observed when essential oil from UC-198 or UC-19 or RS-1 were added in PDA in high concentration (0.1 ml.). The inhibition was due to high concentration of antifungal substance. It indicates that a particular quantity is needed to check the growth of the fungus. If the concentration is low in a variety/entry, it is susceptible. Whereas in case of higher concentration, it is resistant to wilt. The essential oil of coriander and fennel were not found to have antifungal substance against *F. oxysporum* (Table 3). This indicates that there is a certain specific antifungal substance present in specific variety/entry of cumin which is responsible for resistance.

Table 3. Effect of essential oil from other spices on growth of *Fusarium oxysporum* sp. *cumini* at 28 ± 1°C incubated for 6 days

S. No.	Entry	% fungal growth inhibition	
		Strain I	Strain II
1.	Control	No inhibition	No inhibition
	Cumin		
2.	UC-199	75	100
3.	UC-198	100	80
4.	UC-89	45	30
5.	RS-1	8	40
	Coriander		
6.	UD-41	No inhibition	No inhibition
7.	UD-435	"	"
8.	DH-36	"	"
	Fennel		
9.	UF $(m)^{-1}$	"	"

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CHEMICAL EXAMINATION OF THE ESSENTIAL OIL OF *BLEPHARISPERMUM SUBSESSILE* RHIZOMES— A GOOD SOURCE OF CARVACROL

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ABSTRACT

Volatile constituents of the rhizomes of *B. subsessile* have been investigated to afford six monoterpene hydrocarbons and six phenolic derivatives with a few unidentified terpenoids. The main constituents were carvacrol (63.06%), Desmethylisoincecalin (9.5%) and thymol (12.59%) accounting for 85.15% of the oil. All the compounds except *(2)* have been reported for the first time from this oil together with a new natural acetate or Desmethylisoincecalin and a rare benzoyl ester from its chloroferm extract.

INTRODUCTION

The genus *Blepharispermum subsessile* Wight ex DC locally known as Rasna belongs to the tribe Inuleae of the compositae and includes 10 species.[1] The rhizomes of the plant are used by the local people in the Raipur district of Madhya Pradesh for the preparation of Dhoop and Hawan samagri. No chemical work has been reported so far on the essential oil of this plant. Kulkarni *et al*[2] reported the structure and stereo-chemistry of the four new chromenes from the acetone extract of the plant material. One of the compound Desmethoxy-isoincecalin exhibits oviposition deterrent activity against the potato tuber moth *Phthorimaea operculella*. Our continued interest in searching new sources of perfumary products[3-5] prompted us to investigate the oil by isolating the major components

in pure form and establishing the structure by spectroscopic methods. The minor compounds were identified mainly by GC-Mass. Results of these investigations are discussed in this paper.

RESULTS AND DISCUSSION

The rhizomes of *B. subsessile* were collected from Raipur district of Madhya Pradesh which after hydrodistillation afforded a dark brown essential oil with pleasant spicy odour having yield (1.2% on dry weight basis). The oil after GC and GC-Mass analysis afforded 14 well resolved constituents. Out of them six were monoterpene hydrocarbons and six were phenolic derivatives and two components were unidentified. The major components of the oil included acetate of Desmethylisoincecalin (9.5%), thymol (12.59%), and carvacrol (63.16%) were isolated and identified. The spicy odour of the oil is due to carvacrol and thymol which contribute 75.75% of the total oil. The identification was done by comparing the GC-Mass, ^{1}H NMR and IR with those reported in the literature[6] and the library established by us. Compound (1) obtained as white crystals mp 77-79° (molecular formula $C_{15}H_{16}O_4$, M^+, 260). Its IR spectrum displayed bands at 1760 (ester carbonyl), 1680 (C = 0), 1600. 1470 (aromatic ring) and 1635 (C = C) cm^{-1}. Its ^{1}H NMR spectrum showed a singlet at δ 1.45 (6H) assignable to a gemdimethyl group and two singlet at δ 2.35 and 2.50 attributed to one acetyl and one acetoxy group. An AB quartet centered at δ 5.70 (J = 10 Hz) and δ 6.70 (J = 10 Hz) assignable to two olefinic protons. Another AB quartet centered at δ 6.35 (J = 8Hz) and 7.60 (J = 8Hz) to ortho protons of aromatic ring. Considering the above data compound (1) seems to be a derivative of 2.2 dimethyl chromene in which both the acetyl and acetoxy groups are ortho to each other. Further this structure (1) is confirmed by the compound (2) isolating and identified as desmethyl isoincecalin and on acetylation gave the same compound as (1). (IR, ^{1}H NMR, Mass)

Benzyl-2, 6 dimethoxy benzoate (3) : colourless crystals, mp 65-67°C, molecular formula $C_{16}H_{16}O_4$ (M^+ 272) having mass fragrants at m/z 165 (100, $C{=}O^{OCH_3}_{OCH_3}$) and m/z 91 (80, CH_2) and IR displayed signal at 1740 (ester carbonyl) and 1600 cm^{-1} (Aromatic), and on alkaline hydrolysis gives two products Benzyl

alcohol and 2.6 dimethoxy benzoic acid. So it is a benzoate ester having structure (3)[7].

Table 1. Composition of the Essential oil from the rhizomes of *Blepharispermum subsessile*

Peak	Compound	Area percentage	Identified by
1.	α-pinene	0.30	a, b
2.	α-terpinene	0.35	a, b
3.	limonene	0.36	a, b
4.	γ-terpinene	0.68	a, b
5.	p-cymene	9.67	a, b, c, d
6.	U.I.	0.23	—
7.	terpinolene	0.54	a, b
8.	Acetate of Desmethyl isoencecalin	0.75	b, c, d
9.	Desmethylisoincecalin	9.53	b, c, d, e
10.	Carvacrol methyl ether	0.59	a, b, c
11.	p-cymene-8-ol	0.72	a, b, c, d
12.	carvacrol	63.16	a, b, c, d
13.	Thymol	12.59	a, b, c, d
14.	U.I.	0.32	—

a = Rt, b = MS, C = IR, d = ^{1}H NMR, e = ^{13}C NMR,,
U.I. = unidentified.

EXPERIMENTAL

Fresh rhizomes of *B. subsessile* were collected by our taxonomist from the Raipur district of Madhya Pradesh. The specimen voucher has been deposited in the herbarium of our Institute. 1.0 kg rhizomes of *B. subsessile* after hydrodistillation afforded dark brown coloured essential oil 12 gm (yield 1.2%) d^{20} 0.9972, nD^{20} 1.4968, 80 MHz ^{1}H NMR were recorded on varian FT-80A instruments. The chemical shifts are given in δ units. GC was done on Perkin Elmer gas chromatograph 3920B using 2m x 0.3 mm, stainless steel carbowax-20M column. The column temperature was programmed from 60-200°C at the rate of 4°/min, using hydrogen as carrier gas at the flow rate of 30 ml./mint, GC/MS was done on Finnigan Mat 4500 using carbowax 20M capillary column programmed at as initial temperature 60°C than 5°/min, to 300°C with helium as carrier gas.

The oil (10 ml.) was chromatographed over silica gel column eluting with hexane, hexane-ethyl acetate, (97:3), (95:5), (90:10) and finally with hexane-ethyl acetate (85:15) mixture. Fraction (1) and Fraction (2) eluting with hexane and hexane-ethyl acetate (97:3) contained p-cymene, limonene as the major constituents. Fraction (3) (6.5 g) on further chromatography yielded two compounds carvacrol and p-cymene-8-ol. Fraction 4(2.3 g) on further chromatography yielded cumin acetate thymol and cumin. Fraction (5) 0.5 g is still unidentified.

Hexane extract of *B. subsessile* plant rhizomes (2% yield) 5 g on column chromatography yielded two compounds viz β-sitosterol, and benzyl-2, 6 dimethoxy benzoate.

Acetate of Desmethylisoincecalin (**1**) : mp 77-79°C, IR ν_{max}^{kBr} cm^{-1} : 2990, 2920, 1770, 1680, 1635, 1600, 1470, 1365, 1270, 1200, 1115, 1065, 980, and 800. ^1H NMR ($CDCl_3$) 80 MHz: δ 1.45 (6H, s) 2.30 (3H, s), 2.50 (3H, s), 5.70 (1H, d, j = 10Hz), 6.35 (1H, d, J = 8Hz), 6.70 (1H, d, J = 10Hz), 7.60 (1H, d, J = 8Hz), MS : m/z (rel. int.%) 260 (16), 245 (M^+ -CH_3, 5), 218 (M^+ - 42, 20), 204 (100, base peak), 185 (12), 77 (11), 51 (9), and 43 (95), (Found C, 68.94 : H, 6.30 Cal. for $C_{15}H_{16}O_4$ C, 69.23 : H, 6.15%).

Benzyl-2, 6-dimethoxy benzoate (**3**) colourless cristals, mp. 65-67°C, uv λ max 240, 246, 252, 258 and 280. IR ν_{max}^{kBr} cm^{-1} 3050, 2880, 2820, 1740, 1600, 1480, 1440, 1370, 1300, 1260, 1110, 1046 and 910. ^1H NMR ($CDCl_3$) : δ 3.80 (2 x CH_3, s), 5.35 (2H, s), 6.50 (2H, d, J = 8Hz), 7.1 to 7.40 (6H, m), MS m/z (rel. int. %) : M^+ 272 (28), 241 (3), 185 (5), 165 (100), 138 (40), 122 (9), 107 (22), 91 (65), 83 (18), 77 (15), 65 (12), 45 (32), Found C, 70.24 : H, 6.10 Cal. for $C_{16}H_{16}O_4$ C, 70.58 : H, 5.92%).

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ESSENTIAL OILS FROM UNEXPLOITED INDIGENOUS PLANT RESOURCES

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ABSTRACT

India has a varied climate and its flora abounds in a number of essential oil-bearing plants growing in natural state. Only a few are established commercially and a large number are still left unexploited. There is a dire need of extensive examination of this flora which will lead to the discovery of the newer raw materials and also newer oils of considerable importance in domestic and international market.

With this view investigations were undertaken at National Botanical Research Institute. Few plants have shown very promising results. The notable are *Atalantia monophylla* Correa., *Blumea laciniata* DC, *B. mollis* Merr., *Bursera serrata* Wall., *Pogostemon benghalensis* Kuntze, *Schinus terebinthefolius* Raddi, etc. Chemical studies on the oils from these plants are discussed in the present communication.

INTRODUCTION

The demand of aromatic materials is increasing domestically as well as in international market at the rate of 20% every year. Presently the demand is fulfilled by the cultivation of well established aromatic plants or by synthetics. Synthetic materials are mostly produced from coal tar or petroleum products. The natural resources of coal tar and petroleum are declining and are expected to last for 30 to 40 years only as per their consumption rate at present. So the industry will again have to depend on the alternative renewable plant resources for its requirement. Therefore, there is a

need to have a close look on the aromatic flora of the country for the development of essential oil and pharmaceutical industries to compete in the international market and also to meet the domestic requirement.

Out of a large number of flora only a few are established commercially and a large number are still left unexploited. Intensive examination of the wild flora will lead to the discovery of new essential oil which will find considerable application in future in the domestic and international market.

Taking the above points into consideration investigations on the unexploited aromatic flora have been undertaken at National Botanical Research Institute, Lucknow. *Atalantia monophylla* Correa, *Blumea laciniata* Roxb, *Bursera serrata* Wall, *Pogostemon benghalensis* Kuntze and *Schinus terebinthefolius* Raddi. gave promising results.

The plant materials for examination were collected from the gardens of NBRI and different areas around Lucknow except *P. benghalensis* which was supplied by M/S Pharmaceuticals & Crude Drugs Enterprisers, Arming Distt. Nainital. The oil from the plant material was obtained by hyro-distillation, and their physico-chemical properties were studied. The components of the oils were examined by GLC/MS and the presence of major constituents was confirmed by Co-TLC and Co-GLC and spectral studies in some cases.

RESULTS AND DISCUSSION

Results of the findings are as follows :

Atalantia monophylla Correa. syn *A. malabarica* (Rafin) Tanaka belongs to natural order Rutaceae and commonly known as wild lime. It is a small tree with thorny branches distributed throughout the mountaneous region of South India, Assam and extending upto Andamans. The wood forms a durable timber and is used for making cabinets and furniture. The berries and leaves are reportedly used in medicines in South India and Sri Lanka for the cure of various ailments.

The leaves bear a fine lemon like odour with a floral note. The oil yield was 0.3% on fresh weight basis (W/V). It contained 42% terpenes and 50% oxygenated compounds; among these sabinene (28.5%) and methyl isoeugenol (33%) were the major constituents.

The other constituents identified were trans ocimine, α-thujene, α-terpinene, γ-terpinene, β-phellandrene, elemene, 3-hexen- 1-ol, geraniol, linalool, sabinene hydrate, linalyl acetate, decanal, methyl anthranilate, nerolidol, caryophyllene.

The presence of methyl isoeugenol is a novel feature of this oil. It has not been reported in Rutaceae family so far and that too in such a high concentration. The other sources of methyl iso eugenol reported are *Cymbopogon javansis* and *Assurum arifoloum* and in minor amount is reported in other oils also. This is a important perfume chemical applied in fancy and flower perfumed. The oil as such may find application in scenting soaps, toilettories and cosmetic goods, perfume blending and as a source of methyl iso-eugenol.

Pogostemon benghalensis Kuntze Fam. Lamiaceae is a plant indigenous to India. Another species *P. cablin* (Blanco) Benth. Which is not indigenous to India, is the main source of commercial patchouli oil. Its experimental cultivation had been tried through the agencies of Forest Research Lab; Bangalore, Regional Centre of CIMAP, Bangalore and Cinchona department of Tamilnadu and West Bengal. The cultivation could not be very successful owing to the disease caused in the plants by nematode infections. This infection was more severe in northern part of country. Taking this consideration into account and the importance of patchouli oil, other species of *Pogostemon* indigenous to India were investigated. *P. benghalensis* oil was found much closer to the oil of *P. cablin*. Its leaves on hydro-distillation gave 0.5% of viscous oil on dry weight basis having brown colour, pleasant and fruity odour. The physico-chemical properties GLC and TLC Chromatograms corresponded to that of commercial patchouli oil, which is largely imported. The oil may find application in industry as a substitute to the pachouli oil of commerce.

Schinus terebinthefolius Raddi (Fam. Anacardiaceae). In India it is cultivated as an ornamental tree. The leaves on hydro-distillation gave 0.5% of an oil on fresh weight basis. The oil on GC/MS examination was found to contain predominantly α-Pinene (52%). The other constituents identified were cis pinane, dodecaal-dehyde, β-pinene, sabinene, cis verbinene caryophyllene, citral, terpenyl acetate, heptenone, cadinol, Linalood (5.32%), borneol.

Bursera serrata Wall Fam. Burseraceae is a genus of balssammiferous shrubs or trees native to Tropical America. The

species *B. delpichiana* (Posse & Engle syn *B. penincillata* (Sesse & Moe) ex DC) yields the linalool oil of commerce. The oil is obtained from bark, husk and wood. Its, cultivation is done in South India around Mysore and Bangalore. There is tremendous demand of linalool and linalool oil in perfume and flavour industry, so in order to find out additional source, studies on the oil from *Bursera serrata* Wall; another species of the plant was undertaken and that too form the leaves of tree.

B. serrata Wall. grows wild in Bihar and Orissa in abundance and is native to India. The major constituents of the oil found were linalool (53%), terpineol (26%). The other constituents identified were myrcene, limonene, nonanol, citronellal, linalyl acetate, geraniol, carypohyllene caryophyllene oxide, benzyl cinnamate, benzyl benzoate, bisabolol and two unidentified sesquiterpenic alcohols.

Bursera serrata leaf oil has a slightly different odour from that of linalool oil, hence, it can not replace linalool oil in perfumes but it can make its place in industry owing to fine lavender like odour and high linalool content in addition to terpineol. It can also be a vital source for linalool.

Blumea Sps. (Fam. Compositate) comprises about 80 species as annual and perinneal herbs distributed all over tropical Asia. About 35 sps. are reported to occur in India. Most of these species are aromatic and grow wild.

Blumea laciniata is also a seasonal herb growing abundantly in India in the months of January to April. Its areal portion gave 0.1 percent oil on fresh weight basis by hydro-distillation. On chemical examination the oil was found to contain chrysanthenone (7.89%). The main major constituent present in the oil was caryophyllene (64%). The composition of the oil showed that the oil can be a good source for caryophyllene and possibly may find application for scenting soap, cosmetics and burning sticks. Also present were bornylene, camphene, myrcene, phellandrene, methyl heptenone, fenchyl alcohol,/ elemol, methyl farnasate, benzyl alcohol and thymol.

The oil of *S. terebenthifolius* can be a good source of α-pinene which is much required raw material in the perfume industry. With the growing synthetic perfume chemical industry the demand of α-pinene is also increasing. The oil from the leaves of *S. terebin-*

thefolius may suppliment this demand. Besides the oil can also find application for scenting the soaps and detergents.

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FUNGITOXIC AND CHEMICAL INVESTIGATIONS OF *HYPTIS SUAVEOLENS* OIL.

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ABSTRACT

The volatile oil of Wilayati tulsi, *Hyptis suaveolens* Poit (Lamiaceae) showed strong fungitoxic activity against several fungal pathogens and non-phytotoxic activity towards *Vigna radiata*. Its activity was not affected on storage and autoclaving and has been found to be more potent as compared to synthetic fungicides. Three new sesquiterpene alcohols of guaiene series have been isolated from its oil and their structures have been established by spectroscopic analyses.

INTRODUCTION

Higher plants have been used for centuries to cure human diseases. So the scientists have been encouraged to screen these plants for various biological and antifungal activities [1-3]. Essential oils and their constituents have been reported to be less toxic, more systemic[4], easily biodegradable[5], host metabolism stimulatory[6] and non-pollutive. Most of the species of *H. suaveolens* are quite aromatic and are used as an indegenous medicine for various ailments.[7-11]

Nayak and Guha[12] reported sabinene, limonene and 1-guaiene from *H. suaveolens* oil by fractional distillation technique under reduced pressure. Luz *et al.*[13] have also reported the presence of α-guiene by comparing the GC retention values with the authentic

compounds. However, limonene and sabinene were found to be absent.

We have undertaken the fungitoxic and phytotoxic studies on *H. suaveolens*. Further, the oil was subjected to column chromatography (CC). Three new sesquiterpene alcohols are separated and identified by spectral analyses.

EXPERIMENTAL

Hyptis suaveolens (fam. Lamiaceae) is a common weed. It was collected from the campus of Gorakhpur University Gorakhpur, U.P. (India) in the month of September, 1990. Shade dried leaves of the plant (4 kg) were hydrodistilled with the help of Clevengor's apparatus in batches to obtain 25 ml. oil (yield 0.65%). The physico- chemical constants of the oil were determined by following Langaneau[14] and their data are found to be d^{30} 0.9182, n_D^{27} 1.4733, $[\alpha]_D^{28}$ - 62.5°.

Table 1. Fungitoxic spectrum of the oil of *Hyptis suaveolens* Poit

Sl. No.	Fungi tested	Percent Mycelial Inhibition		
		500 ppm	1000 ppm	2000 ppm
1.	*Aspergillus niger*	80.7	90.2	100.0
2.	*Aspergillus flavus*	50.6	70.5	100.0
3.	*Aspergillus sydowii*	60.0	80.2	97.0
4.	*Aspergillus parasiticus*	68.2	77.0	90.0
5.	*Penicillium italicum*	70.0	72.6	80.2
6.	*Penicillium oxalicum*	50.0	55.2	80.0
7.	*Penicillium citrinum*	27.5	30.5	57.8
8.	Ceratocystis paradoxa	50.8	100.0	100.0
9.	*Colletotrichum falcatum*	80.0	100.0	100.0
10.	*Colletotrichum gloeosporoides*	48.0	69.5	100.0
11.	*Curvularia lunata*	70.4	91.0	100.0
12.	*Curvularia pallescens*	62.5	85.2	100.0
13.	*Periconia atropurpurea*	52.0	100.0	100.0
14.	*Fusarium oxysporum*	52.5	100.0	100.0
15.	*Fusarium udum*	70.0	100.0	100.0
16.	*Fusarium moniliforme*	80.3	100.0	100.0
17.	*Helminthosporium oryzae*	87.5	100.0	100.0
18.	*Rhizoctonia solani*	37.0	68.3	100.0
19.	*Pythium debarvanum*	43.2	59.0	100.0
20.	Pythium aphanidermatum	56.0	68.6	100.0
21.	*Sclerotium rolfsii*	50.0	67.0	100.0
22.	*Alternaria alternata*	62.5	80.7	100.0

(i) ***Fungitoxic behaviour***

The fungitoxicity of the oil was tested against the test fungi by following Poisoned-Food Technique [15-17]. Each test was replicated four times and data are presented in Table-1. The detailed fungitoxic investigations of the oil were made against *Aspergillus flavus, Collatotrichum falcatum* and *Fusarium moniliforme.* The minimum inhibitory concentrations (MIC) and fungistatic and fungicidal nature of the oil was also determined by following Garber and Houston method[18] and results are reported in Table-2. The effect of storage, temperature and autoclaving of the oil on fungitoxicity was sudied by the technique of Dixit[19] and data are presented in Table-3. The efficacy of the oil was also compared with the prevalent commercial synthetic fungicides, viz. Agrosan GN, Bavistin, Blitox-50, Dithane M-45, Dithane Z-78 and Tropsil M. The results are given in Table-4.

Table 2. Minimum Inhibitory Concentration of the oil of *Hyptis suaveolens* Poit

Concentrations (ppm)	Percent mycelial inhibition			Growth (%) of inhibited mycelial disc after transfer to oil free medium		
	A. flavus	*C. falcatum*	*F. moniliforme*	*A. flavus*	*C. falcatum*	*F. moniliforme*
250	29.5	50.0	44.6	—	—	—
500	80.7	82.0	90.0	—	—	—
1000	90.2	100.0	100.0	—	0.0	0.0
2000	100.0	100.0	100.0	0.0	0.0	0.0
4000	100.0	100.0	100.0	0.0	0.0	0.0

Table 3. Effect of some Physical Factors on Fungitoxicity of Hyptis oil at 2000 ppm

Physical factors		Percent mycelial inhibition		
		A. flavus	*C. falcatum*	*F. moniliforme*
Effect of temperature (0°C)	50	100.0	100.0	100.0
	75	100.0	100.0	100.0
	90	100.0	100.0	100.0
Effect of autoclaving (15 lb/sq. pressure for 30 min.)		100.0	100.0	100.0
Effect of storage (days)	30	100.0	100.0	100.0
	60	100.0	100.0	100.0
	90	100.0	100.0	100.0

Table 4. Efficacy of Essential oil of *Hyptis suaveolens* compared with synthetic Commercial Fungicides against Fungal Pathogens.

Common Name of fungicide	Trade Name of fungicide	MIC (%) against fungal pathogens		
		A. flavus	*C. falcatum*	*F. moniliforme*
Carbendazim	Bavistin	3000	3000	2000
Copper oxychloride	Blitox-50	2000	3000	3000
Mancozeb	Dithane M-45	2000	3000	3000
Organomercurial dust	Agrosan GN	2000	2000	3000
Thiophenate-Methyl	Topsil M	4000	3000	4000
Zineb	Dithane Z-78	3000	2000	4000
Oil Sample	—	2000	1000	1000

(ii) Phytotoxic behaviour

The phytotoxic effect of the oil, tested on seed germination and seedling growth of *Vigna radiata*, was studied following Tripathi et al[20]. and data is reported in Table-5

Table 5 : Phytotoxicity of *H.suaveolius* oil (2000 ppm) on moong bean plant (*Vigna radiata*)

Germination %			Shoot length (mm)		
Periods (hrs)	Control	Treated	Periods (Days)	Control	Treated
24	85	80	3	30	33
48	90	82	5	46	54
72	96	89	7	92	110

(iii) Chemical constituents

The *H. suaveolens* oil was separated into 10 fractions by CC on silica gel (Qualigens, India) and a mixture of petrol and EtOAc. The polarity of eluent was increased using EtOAc in the following proportions : 99:1, 97:1, 19:1 and 9:1. The compound 1 was found to contain in frs 2, 3 and 4 (1.2g, the petroleum ether-EtOAc, 19:1, Rf 0.60), compound 2 was in frs. 1 and 2 (18 mg, R_f 0.40); and compound 3 was in frs. 5 and 6 (32 mg, R_f 0.22). These compounds were purified by repeated silica gel CC followed by preparative TLC. The ^1H NMR spectra (Varian 3M-360L) of the purified compounds were measure

in $CDCl_3$ solution at 90 MH_3 with TMS as an internal standard. Chemical shifts are given in δ units. The IR spectra of the compounds were taken on Perkin Elmer 881 model. The absorption range was 4000-600 Cm^{-1}. The MS (JMS, Jeal D-300) of the compounds were also taken at 20 and 70 ev respectively. The spectral data of compounds 1,2 and 3 are summarized as follows :

Compound-1

Viscous mass, $[\alpha)_D^{28}$ - 74.4° (C_2H_5OH; 0.1), IR ν_{max}^{neat} cm^{-1}; 3450 (OH), 3090 (C=CH_2), 1650, 1220, 1010, 880 (C = CH_2); MS M/Z (rel. int.) : 220 ($[M]^+$, $C_{15}H_{24}O$) (5), 202 (2), 187 (5), 177 (12), 162 (6), 121 (34), 107 (42), 93 (79), 81 (47), 69 (17), 57 (11), 43 (100), 41 (26); ^1H NMR ($CDCl_3$) : δ 0.96 (d, J = 7.0 H_z, H-14), δ 1.44 (S, 3H, H-15), δ 1.55 (brs. 1H, OH), δ 1.67 (S, 3H, H-13), δ 4.70 (brs, 2H, H-12), δ 5.72 (brs, 1H, H-2).

Compound-2

Viscous mass, IR ν_{max}^{neat} cm^{-1} : 1460 (— ⟨ CH), 3440 (-OH), 3070 (C = CH_2), 1655 (C = C), 1380, 1220, 900, 810, 769 (= CH_2); MS, M/Z (rel. int) : 220 ($[M]^+$, $C_{15}H_{24}O$) (4), 202 (5), 187 (10), 177 (3), 169 (5), 161 (11), 93 (20), 81(45), 68 (27), 57 (70), 43 (100). 41 (14); ^1H NMR ($CDCl_3$); δ 0.92 (d, J = 7.0 H_z. 3H, H-14), δ 0.98 (d, J = 7.0 H_z, 6H, H-12 and 13), δ 1.44 (S, 3H, H-15), δ 1.55 (brs, 1H, OH), δ 5.30 (m, 1H, H-8).

Compound-3

Oily mass IR ν_{max}^{Film} cm^{-1}; 3420 (-OH), 3060, 1660 (C = C), 1145, MS M/Z (rel int.) : 222 ($[M]^+$ $C_{15}H_{26}O$) (3), 207 (5), 204 (7), 186 (2), 164 (4), 161 (8), 149 (20), 135 (96), 122 (15), 121 (20), 93 (40), 91 (38), 81 (52), 67 (32), 55 (68), 59 (95), 43 (100); ^1H NMR ($CDCl_3$) : δ 1.00 (S, 3H, H-12), δ 1.14 (s, 3H, H-13), δ 0.82 (d, J = 6.5 H_z, 3H, H-15), δ 1.04 (d, J = 6.5 H_z, 3H, H-14).

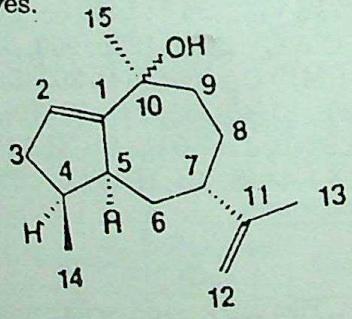
RESULTS AND DISCUSSION

Essential oil of *H. suaveolens* was found to exhibit fungitoxic activity (100% mycelial inhibition) against. *C. paradoxa, C. falcatum, F. atropurpurea, F. moniliforme, F. oxysporum, F. udum, H. oryzae* at 1000 ppm and 2000 ppm concentrations (Table 1). However, it showed complete mycelial inhibition of *A. niger, A. flavus, C.*

gloeosporoides, C. lunata, C. pallescens, R. solani, P. debaryanum, P. aphanidermatum, S. rolfsii and *A. alternata* at 2000 ppm concentration (Table 1). The oil was also found to be weakly active against *A. sydowii, S. parasiticus, P. italicum, P. oxalicum and P. citrinum* at all the test concentrations (Table-1).

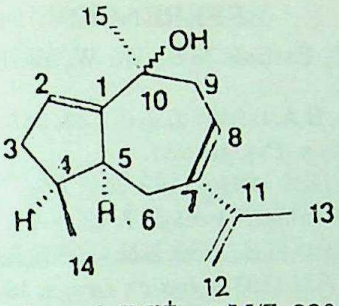
The MIC of the oil against *A. flavus, C. falcatum* and *F. moniliforme* was found to be 2000 ppm, 1000 ppm and 1000 ppm respectively (Table 2). The antifungal activity of the oil was not affected by autoclaving, temperature upto 90°C and storage upto 90 days (Table-3). Further, the oil showed lower MIC as compared to synthetic fungicides (Table-4). It also exhibited no adverse effect on seed germination and shoot length of *Vigna radiata* (Table 5). Thus, the oil was found non-phytotoxic towards *V. radiata* at lethal dose towards pathogens.

The structures of the compounds 1, 2 and 3 isolated by CC and TLC (preparative) were deduced from the spectral data and confirmed by comparison with the published information [21-26] for the compounds themselves.



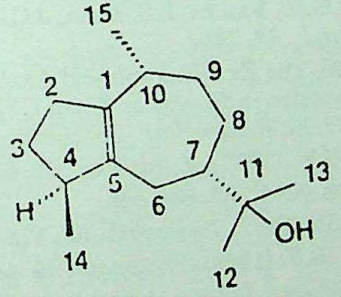
1

The MS of 1 showed $[M]^+$ at M/Z 220 indicative of a sesquiterpenoid. This was further supported by its ^1H NMR spectrum which showed broad singlet at δ 4.70 (equivalent to 2H) and a singlet at δ 1.72 (3H, vinyl CH_3), and IR absorption bands at 3080, 1650 and 880 cm^{-1} confirms the presence of isopropenyl group. A broad singlet at δ 1.56 (1H, OH), IR absorption band at 3450 cm^{-1} attributed to a hydroxyl group, singlet at δ 1.44 (3H), and the absence of other olefinic protons suggested that the hydroxyl group is attached to quaternary carbon. We could not assign the stereochemistry at C-4, C-5 and C-10. The structure of 1 was, thus, established as guaia - 1(2)-11-dien - 10-ol. Furthermore, this structure was also confirmed by comparison of its IR, ^1H NMR and MS spectra with the reported data of reference[21].



2

The MS of 2 showed $[M]^+$ at M/Z 220 indicating that the compound has a molecular formula $C_{15}H_{24}O$. The base peak at M/Z 43 confirmed the presence of isopropyl group. Its ^1H NMR spectrum was quite similar to compound 1 but the striking difference is in the chemical shift of isopropyl proton at δ 0.98 (d, 6H) ppm. Therefore, compound 2 is guaia-1(2), 7-diene-10-ol, an isomer of 1.



3

The MS of 3 showed $[M]^+$ at 222 again indicate the presence of sesquiterpenoid which was found to be an alcohol due to its IR absorption band at 3420 cm^{-1}. Its ^1H NMR spectrum showed singlets at δ 1.14 and δ 1.16 for the protons at C-12, C-13 (3H, each) and a doublet at δ 0.78 (3H, d, J = 6.5 H_z) ppm for C-15 proton, indicative of the attachment of OH at C-11. This was further confirmed by a MS peak at M/Z 59 and indicates the presence of hydroxy isopropyl group at C-1 in 3. Thus, these data suggested that the compound 3 is guia-1(5), en-11-ol.

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ANTIMICROBIAL ACTIVITY OF THE ESSENTIAL OILS OF SOME INDIAN *ARTEMISIA* SPECIES

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ABSTRACT

Essential oils hydrodistilled from Eleven species of *Artemisia viz. A. dracunculus, A. edgeworthii, A. gmelini, A. Caciniata, A. maritima, A. moorcroftiana, A. nilagirica, A. parviflora, A. roxburghiana, A. scoparia* and *A. tournefortiana,* were tested for their in vitro antimicrobial activity against 10 human pathogenic bacteria and fungi. It was found that most of the specis showed good antagonistic activity against bacteri viz. *E. coli, Kleb . pheumoniae, Pseudo aeruginosa, S. aureus* (Penicillin resistant) while only some species responded well against the fungal organisms used and no activity was observed against *Trichophyton mentagrophytes.*

INTRODUCTION

The genus *Artemisia* (family Asteraceae) is one of the largest genera comprising nearly 300 species, out of which 37 species have been recorded from India[1]. Several types of activity viz. anthelmintic, anticomementary, antidiabetic, antifertility, antihepatotoxic, antimalarial, antiplaque, antitumor, hypotensive and insecticidal etc. have been reported from different species of *Artemisia*[2]. Although antimicrobial activity of the essential oils of *A. dracunculus, A. herba alba, A. haplopila, A. nilagirica, A. pallens, A. parviflora, A. vestita* and *A. vulgaris* have been reported by several workers[2-9],

Table 1- Procurement of material (*Artemesia* species)

Species	Collection Number	Collection Site	Above MSL in m	Distribution in India
A. dracunculus Linn.	9305	Koksar [Lahul and Spiti] H.P.	3200	Lahul and Spiti, above 3000 m
A. edgeworthii Balak	17267	Gangotri (Uttar kashi) U.P.	3000	Tibetan passes of Himalayas, Kumaon 3000-3500 m. Sikkam 500 m.
A. gmelini Web ex Stechm.	6737A	Sissu-Gondhla [Lahul and Spiti]	3200	Kumaon to Kashmir from 2700 to 5000 m.
A. laciniata Willd.	10697	Gemur [Lahul and Spiti] H.P.	3200	Kumaon to Kashmir, above 2400 m.
A. maritima Linn.	6739	Sissu-Gondhla [Lahul and Spiti] H.P.	3200	Kumaon to Kashmir, upto 4000 m.
A. moorcroftiana Wall. ex DC	6929	Chatru [Lahul and Spiti] H.P.	3300	Himachal Pradesh to Kashmir, upto 4200 m.
A. nilagirica (Cl.) Pamp.	17231	Marhi-Gulaba (Kullu) H.P.	2400	Throughout mountainous regions from 700 to 3500 m.
A. parviflora Ham. ex D. Don	10287	Jispa [Lahul and Spiti] H.P.	3500	Throughout mountainous regions from 1200 to 3500 m.
A. roxburghiana Wall. ex Besser	10619	Mussoorie [Dehradun] U.P.	1700	Kumaon to Kashmir from 1500 to 3000 m.
A. scoparia Waldst. & Kit.	10351	Darcha [Lahul and Spiti] H.P.	3500	Western Himalayas form 1500 to 2100 m. Upper Gangetic Plains and Punjab.
A. tournefortiana Reichb.	10764	Jahlma [Lahul and Spiti] H.P.	3000	Himachal Pradesh to Kashmir from 2400 to 3600 m.

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however, no such work has been carried out with the *Artemisia* species presently taken up for the study except *A. dracunculus, A. niligarica* in which the results obtained are quite different than ours. Thus, the essential oils of all the species mentioned in the Table-1 were, evaluated against five pathogenic bacteria viz. *Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Staphylococus aureus* (Penicillin resistant) and *Streptococcus faecalis* and five fungi viz. *Aspergillus fumigatus, Candida albicans, Cryptococcus neoformans, Sporotrichum schenckii* and *Trichophyton mentagrophytes.*

EXPERIMENTAL

Plant material

The aerial parts mainly the floral heads of all the eleven species of *Artemisia* were collected mostly from Lahaul and Spiti region (Himanchal Pradesh) and from hills of Uttar Pradesh (Table 1). The identified voucher specimens are lodged in the herbarium of Central Drug Research Institute, Lucknow, India.

Isolation of essential oils

The air dried plant material of all the species was hydrodistilled. The essential oils thus extracted were subjected to antimicrobial screening.

Antimicribial activity

Four dilutions viz. 1.0, 0.5, 0.25 and 0.125 W/V were prepared in acetone from each essential oils. 200 ml. sterilized Beef extract agar (for bacteria) and Sabourud's Dextrose agar (for fungi) were used for testing. 5 c.c. of 24 hrs old culture for bacteria and 48 hrs old culture for fungi were added to 200 ml melted cooled test agars and after thorough mixing 20 ml. of this seeded agar was poured into 10 cm. diameter presterlized petridishes and allowed to solidify. Filterpaper discs 12 mm. in diameter (prepared from Whatman No. 1 filter paper) were placed in seeded plates after soaking them separately in different dilutions of essential oils. These plates were then incubated at 37° ± 1°C for bacteria and 28° ± 1° C for fungi. The inhibition zones were measured after 24 hrs for bacteria and 48 hrs.

TABLE 2- Comparative antibacterial screening of Artemisia spp.

Species used	Tested Bacteria																			
	E.coli				*Kleb. pneumoniae*				*Pseudo aeruginosa*				*S. aureus*				*Strep. faecalos*			
	Percentagae of essential oils W/V																			
	1	0.5	0.25	0.125	1	0.5	0.25	0.125	1	0.5	0.25	0.125	1	0.5	0.25	0.125	1	0.5	0.25	0.125
A. dracunculus	+	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. edgeworthii	+	–	–	–	+	+	–	–	+	–	–	–	+	+	+	–	+	+	–	–
A. gmelini	+	–	–	–	+	+	+	+	+	–	–	–	+	+	–	–	–	–	–	–
A. laciniata	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. maritima	–	–	–	–	++++	+	+	+	+	+	–	–	+	+	+	+	–	–	–	–
A. moorcroftiana	–	–	–	–	++++	+++	+	+	–	–	–	–	–	–	–	–	–	–	–	–
A. nilarigica	+++	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. parviflora	–	–	–	–	+++	+	+	+	+++	+	+	+	+++	+	+	–	+++	+	–	–
A. roxburghiana	+++	+	+	+	++++	+	+	+	+	+	+	+	+	+	–	–	–	–	–	–
A. scoparia	+++	+++	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. tournefortiana	+	–	–	–	+	+	+	+	+	–	–	–	–	–	–	–	–	–	–	–
Gentamycin 10 µg/disc		+++				++++				++++				+					–	
Neomycin 30 µg/disc		++++				+				++++				++++					+++	

–= Resistant; += 13–17 mm; ++= 18.22 mm; +++= 23–27 mm; ++++= 28–32 mm.

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for fungi. The evaluation of inhibitory properties was carried out in duplicate with two replicates on each occasion along with the control. Control microbial sensitivity test was also performed with biodises of Neomycin and Gentamycin 30 μg and 10 μg per disc respectively.

RESULTS AND DISCUSSION

Antagonistic activity of various dilutions of essential oils against human pathogenic bacteria and fungi has been recorded in Table 2 and 3 respectively. It is quite evident from Table 2 that oils of *A. parviflora* and *A. roxburghiana* show maximum inhibition against most of the bacteria followed by that of *A. maritima.* In contrast, the oils of *A. scoparia* and *A. nilagirica* are quite specific in their activity and inhibitonly the growth of *E. coli* mainly responsible for UTI[10]. Similarly the oil of *A. moorcroftiana* is active against *Kiebsiella pneumoniae* only. Rest of the oils tested are not much effective against any of the bacteria used in the experiment. In variance to our observations regarding the oil of *A. dracunculus,* Deans and Katerina (1988) reported that it shows activity against most of the pathogens (used by us), while our material of the same specie was found acxtive only against *E. coli* and *Kleb. pneumoniae.* These differences in the activity might well be explained due to ecological variation so frequently found in the chemical composition of essential oil as studied by Benouda et. al[5]. On the contrary the activity of these oils against the fungal organisms is quite meagre (Table-3). The only noteworthy results have been obtained in respect of *A. dracunculus* and *A. parviflora* which are active against *Candida albicans* and *Sporotrichum schenckii.* Besides, *A. dracunculus* is also actaive against *Aspergillus fumigatus* and *A. parviflora* against *Cryptocoocus neoformans* and *Trichophyton mentagrophytes.* However, in contrast to our observations Kishore and Dubey (1988) reported that the oil of *A. nilagirica* exhibited complete inhibition of *Trichyophyton rubrum* and *Epidermophyton floccosum* even at a concentration of 250 ppm [7,8]

Table 3. Comparative antifungal screening of Artemisia spp.

Species used	Tested Bacteria																			
	Aspergillus fumigatus				*Candida albicans*				*Cryptococcus neoformans*				*Sporotrichum schenckii*				*Trichophyton mentagrophy*			
	Percentagae of essential oils W/V																			
	1	0.5	0.25	0.125	1	0.5	0.25	0.125	1	0.5	0.25	0.125	1	0.5	0.25	0.125	1	0.5	0.25	0.125
A. dracunculus	+	+	–	–	+++	+	+	–	–	–	–	–	+++	+++	+	+	–	–	–	–
A. edgeworthii	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. gmelini	–	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
A. laciniata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. maritima	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. moorcroftiana	–	–	–	–	+	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–
A. nilarigica	–	–	–	–	+++	+	–	–	–	–	–	–	+++	+	+	–	–	–	–	–
A. parviflora	–	–	–	–	+++	+	+	+	+	+	–	–	++++	+	+	–	+	+	–	–
A. roxburghiana	–	–	–	–	++++	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–
A. scoparia	–	–	–	–	++++	+	+	+	+++	+++	+	+	–	–	–	–	–	–	–	–
A. tournefortiana	+++	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–

–= Resistant; += 13–17 mm; ++= 18.22 mm; +++= 23–27 mm; ++++= 28–32 mm.

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QUALITY CHARACTERISTICS OF DIFFERENT TYPES OF BETEL LEAVES.

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ABSTRACT

Betel leaves alongwith arecanut and spices are used as a masticatory in the subcontinent. The leaves are aromatic with varied taste ranging from sweet to pungent due to the presence of essential oil. Within a variety, the quality of the betel leaves can be improved by processing viz. bleaching and by retaining the leaves on the vine for a longer period during winter months 'Vaisakhi pan'. The mother leaves ('Pedi pan') in the cuttings after the establishment of new plants are also known for their quality.

The concentration and composition of essential oil influence the aroma and flavour of the leaves. Besides essential oil, chlorophylls, carotenoids, proteins, sugars, moisture percentage determine the taste and quality of bleached leaves, 'Vaisakhi pan' and 'Pedi pan'. Quality characteristics of these three types of leaves have been presented in detail. The results of analyses are discussed.

INTRODUCTION

Within a variety, the quality of betel leaves can be improved by retaining the leaves on the vine for a longer period. Usually the entire leaves are harvested just before lowering the vines in the month of March. During disease free years, the farmer does not get a remunerative price due to glut in the market. When the price levels are low, the cultivator tries to retain the leaves on vine upto May-

June by bringing down the vine to a meter from the ground level and training the vines horizontally in crisscross fashion to avoid exposure to hot sun. The leaves from such semi lowered vines are called 'Vaisakhi pan' and are preferred for their quality.

Immediately after the young plants are well established in new plantations, the mother leaves ('Pedi pan') which supported the new sprouts are harvested during May-June and sold at premium price in the market, because of the unique quality of 'Pedi Pan'.

Bleached yellow leaves are also known for their excellent quality and fetch more price than the fresh green leaves. Matured leaves are stored in a well ventilated dark room for bleaching which brings about degradative changes in the chlorophylls, sugars and proteins.

It was of interest to study the quality parameters of these three types of betel leaves viz. 'Vaisakhi pan' 'mother leaves' and 'bleached leaves'. The studies were carried out on two commercial cultivars viz. Bangla and Desawari obtained from the experimental betelvine conservatory at Mahaoba (Distt. Hamirpur). While the bleached leaves of two types of cv. Bangla viz. 'Jagannathi' and 'Tamluk' were purchased from the Pandariba market in Lucknow at weekly interval (total 4 times), alongwith fresh leaves which were used as check in the experiment. Chlorophylls a, b and total chlorophyll were estimated according to Arnon, 1949; Carotenoids (Jensen, 1978). carbohydrates as water soluble and acid soluble sugars by phenol sulphuric acid method (Dubois, 1956), proteins were estimated according to Lowery. Essential oil was extracted by hydrodistillation using Clevenger's apparatus. The fatty oil was extracted with diethyl ether.

RESULTS AND DISCUSSION

Observations on chlorophylls, carotenoids, protein, sugars essential oil content of 'Vaisakhi pan' of cvs. Bangla and Desawari and those of mother leaves of these two cultivars and on the chemical analysis of bleached leaves of 'Jagannathi' and 'Tamluk'. Bangla are given alongwith those of fresh leaves used as control are presented in table 1 and 2.

Table 1 : Chlorophyll, carotenoids, proteins, sugars and essential oil content of cv. Bangla and Desawari leaves ('Vaisakhi pan') and mother leaves of Bangla and Desawari ('Pedi pan').

Parameters	Bangla Vaisakhi	Bangla Pedi	Control
Chlorophyll mg/g			
a	0.804	1.018	0.782
b	1.006	1.046	0.891
Total	1.810	2.064	1.673
Carotenoids (mg/g)	0.115	0.288	0.4
Protein (%)	6.6	5.2	2.74
Sugar (mg/g)			
Water-soluble	3.8	2.86	8.05
Acid soluble	15.5	8.58	17.7
Moisture (%)	83	79.16	83
Essential oil (%) content	0.246	0.45	0.20

Table 2. Chlorophyll, carotenoids, protein, sugar and essential oil content of bleached and fresh leaves of types of cultivar Bangla.

Parameters	Jagannathi bleached	Jagannathi fresh	Tamluk bleached	Tamluk fresh
Chlorophyll mg/g				
a	0.274	1.294	0.793	2.27
b	0.479	1.44	1.24	3.75
Total	0.753	2.74	2.033	6.02
Carotenoids (mg/g)	0.056	0.486	0.159	0.32
Protein (%)	4.56	2.36	3.8	6.1
Sugars (mg/g)				
Water soluble	5.68	11.9	6.5	7.0
Acid soluble	22.5	24.14	25.2	14.5
Moisture (%) Content	85.15	85.7	83.3	84.4
Essential oil (%) content (F.W.B.)	0.393	0.33	0.436	0.17

The leaves of both the cultivars retained on the vine through winter (Vaisakhi pan) were well matured, rich in essential oil and total proteins. The water soluble sugars and carotenoids were less than that of fresh leaves. The preference for such matured leaves seems to be due to higher essential oil content which is responsible for the aroma and taste of these leaves. So also is the case of mother leaves ('Pedi pan'). Obviously the chlorophyll content was reduced in the bleached leaves. The degradation of chlorophyll was almost complete as the bleached leaves contained only 0.753 mg/g as compared to that of fresh leaves (2.74 mg/g). The essential oil content was higher and the sugars were less than that of fresh leaves. Degradation of chlorophyll leads to better taste as the presence of chlorophyll gives a bitter taste.

By maintaining the newly planted vines under hygienic conditions the farmers recover a part of the cost of planting material through the sale of mother leaves. By retaining the leaves on the vine during winter the farmer gets better market price for 'Vaisakhi pan'. During summer months the higher sale price of bleached leaves compensates the processing expenditure.

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A NOTE ON GC-MS ANALYSIS OF ESSENTIAL OIL FROM *ZANTHOXYLUM ALATUM* ROXB. AND ITS BIOLOGICAL ACTIVITY.

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Z. alatum Roxb. syn. *Z. armatum* DC. (Rutaceae) finds [1, 9] extensive application in the indigenous system of medicine. The essential oil is said to possess antiseptic, disinfectant and deodorant properties. The chemical composition of essential oil from the leaves, terminal branchlets [2, 5] and fruits wild [3,7,8] as well as from market [4, 6] were already reported. Recently there was a report [10] on the composition of oil from pericarp.

Z. alatum fruits were collected from near Dehra Dun and dried at room temperature. The fruits were subjected to hydrodistillation using a Clevenger's apparatus (5h) to yield 2.4% oil which possessed a pale greenish yellow colour.

The essential oil was analysed by GC-MS using Hewiett Packard 59.70; column; fused silica capillary (30 M) DW WAX (crosslinked carbowax); temperature programme 40-240°C (2°C/min); injector temp. 245°C; ion source temp. 205°C; carrier gas: Helium; Injected amount 0.12 µl (splitless).

The fruit yielded 2.4% of essential oil has specific gravity 0.9320, refractive index 1.4779, optical rotation + 0.061; acid value 3.97, ester value 24.34. The GC-MS analysis of the essential oil showed the presence of 22 constituents. The major constituents (76.4%) of which were linalool (40.2%), limonene (24.0%), methyl cinnamate (8.0%) and myrcene (4.2%).

Z. alatum a non-eugenol substance having linalool as a major constituent has been employed as a substitute for cytotoxic eugenol.

Zinc oxide-eugenol cement has been known for over hundred years although found cytotoxic. Several modifications were tried to replace eugenol but none of them was found ideal. In the present study eighty cases of either sex between the age group of 20-56 years having carrious exposed tooth needing palliative dressing. The oil from *Z. alatum* gave significantly quicker and longer acting analgesia () besides acting as a cementing material. This showed better bicompatibility as a dental material as it was more acceptable to the patients and less irritant as compared to eugenol (). It was found to be relatively safer clinically, histologically as well as electron microscopically.

The presence of α-thujene, myrcene, α-pinene, sabinene, geraniol, linalool, limonene, α-terpineol and methyl cinnamate, already reported from the pericarp oil [10], have been confirmed in the oil. Their percentage in the oil is, α-thujene (2.01%), myrcene (4.21%), α-pinene (0.08%), sabinene (1.26%), geraniol (2.10%), linalool (40.20%), limonene (24.02%), α-terpineol (1.30%) and methyl cinnamate (8.01%). In addition the oil was found to contain, γ-terpinene (0.86%), 1-8 cineol (0.071%), cisocimene (1.86%), p-cymene (0.68%), α-fenchol (2.09%), camphor (0.88%), carvone (0.52%), tagetonol (0.88%), 3,7-dimethyl 1-1-octene 3,6,7-triol (0.11%), linalyl acetate (2.52%), citral (0.82%), alloaremadendrene (1.05%) and carotol (3.10%).

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ROLE OF NABARD IN THE PROMOTION OF MEDICINAL & AROMATIC PLANTS

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Medicinal and aromatic plants being high value crops, constitute an important segment of horticulture. In India, about 2000 species of medicinal and aromatic plants are under cultivation. The essential oils derived from the aromatic plants have superb olfactive properties and provides balance to the perfume. About one third of world's perfumery raw material market, by value, is covered by essential oils alone. This sector also contributes to foreign exchange to the tune of Rs. 18 crores (1989-90). However, the present export trend is declining thereby warranting the upgradation of cultivation techniques distillation and marketing strategy in order to make our products competitive in international markets.

The essential oils are derived from the herbage, seeds, roots and peels of certain important plants. The important essential oil bearing plants grown in the country are Citronella, Palmarosa, Japanese Mint, Pepper Mint, Geranium, Lemon grass, *Eucalyptus citriodora* etc. which are commonly used in the perfumery, flavour and pharmaceutical industries. Similarly Aonla, Sarpagandha, *Ocimum* sp. *Periwinkle*, Senna, *Dioscorea* sp. etc. are important medicinal plants grown in the country on large scale. The various parts of the plants are utilised in the Ayurvedic formulations.

ROLE OF NATIONAL BANK

National Bank for Agriculture and Rural Development (NABARD) is an apex level institution, constituted in 1982 with a mandate to promote Agriculture and Rural Development in rural areas with a view to secure prosperity among all. In order to boost

the bank credit to this vital sector, it refinances the loans provided by the banks (Commercial Banks, Land Development Banks, Cooperative Banks and Regional Rural Banks). It has initiated a number of promotional measures, inter alia, formulation of Model schemes, conducting workshops etc. As a sequel to it, National Bank has formulated model schemes on Palmarosa, Geranium, Belladonna and Sarpagandha and has been circulated to all the bankers for the formulation of scheme in the potential areas. As far as disbursement of refinance is concerned, during the year 1983-84 the medicinal and aromatic plants share was 0.03% in the total disbursement of horticulture and it has further consolidated the gains in 1991-92 to the extent of 0.59%. Though, it seems to be a small figure, looking at the constraints at various levels, this has been a significant achievement. As a result of National Bank's persuation, number of banks have come forward to finance medicinal and aromatic plants and now reverberating at success stories. To quote, even agriculturally backward regions such as Bihar State, actively involved in the finance to Palmarosa cultivation in Palamau district sponsored by Canara Bank and has availed refinance to the tune of Rs. 7.388 lacs against the total refinance commitment of Rs. 10.800 lacs. Incidentally the scheme was one of the first seeds of Palmarosa in our country. Similar success has been brought in Andhra Pradesh for Citronella, Palmarosa & Geranium in Nalgonda district, Palmarosa in Trichy district and Geranium in Nilgiris district in Tamil Nadu and Citronella in West Bengal State.

Uttar Pradesh State is traditionally famous for Damask Rose cultivation and country stills are in vogue for extracting oil. Taking the advantage to this inherent system, National Bank has sanctioned number of projects to UPSLDB, RRBs and Commercial Banks for Damask Rose cultivation and distillation. This State too tasted success by way of refinance availament to the extent of Rs. 9.157 lacs since 1986. This sector is not exclusive domain of large farmers. Small farmers have readily come forward for cultivation of Damask Rose in Aligarh district and that has been reflected in the credit disbursement of Rs. 3.211 lacs against the contemplated credit programme of Rs. 5.292 lacs by Aligarh Gramina Bank. Another integrated project for Aligarh district sponsored by UPSLDB on Damask Rose cultivation plus Distillation unit involving financial assistance of Rs. 5.780 lacs is under active consideration. The distillation unit proposed in the project en-

visages enhanced oil recovery to the tune of 0.03%-0.04% against the present recovery of 0.004% to 0.0045%.

Further, recognizing the importance of medicinal and aromatic plants, National Bank has given due weightage in the potential linked credit plans for incorporation at the branch level service area plans. Thus, the linkage of potential available and credit has been finally translated at the grass root level.

In addition, National Bank is keeping constant touch with the research institutes for supporting the emergent technologies with credit.

TYPES OF SCHEMES

In order to avail the bank finance the entrepreneur may submit either of three projects viz.:

1. A project for cultivation of aromatic/medicinal plants.
2. A project for cultivation and distillation unit.
3. A project for distillation and further value addition e.g. Menthol crystal manufacturing.

The first two projects come under Farm sector, whereas third project falls under the category of non-farm sector.

The model project formate has been furnished in the annexure–1.

Margin Money : In case of farm sector projects, no margin money will be collected for the loans upto Rs. 10,000.00 irrespective of the category of farmers except for the obligatory share capital for those availing loan from Co-operative banks/Land Development Banks. If the loan amount exceeds Rs. 10,000.00 down payment to the extent of 5%, 10% and 15% of project cost in case of small/marginal, medium and other farmers respectively may be collected. In case of Non-Farm sector (e.g. Distillation plants alone or Menthol crystal manufacturing units etc.) margin money will be as follows :

Loan Amount	Margin Money
Upto Rs. 50,000	NIL
Rs. 50,001 to 1,00,000	5% of project cost
Rs. 1,00001 to 7.5 Lacs	10% of project cost
Over Rs. 7.5 Lacs	12.5% of project cost

Interest Rates : The interest rates will be prescribed by RBI from time to time. The existing interest rates are given bellow;

	Quantum of loan (Rs.)	Farm sector (% p.a.)	Non-Farm Sector (% p.a.)
(i)	Upto & inclusive of Rs. 7,500	11.5	11.5
(ii)	Over Rs. 7,500 upto Rs. 15,000	13.0	13.0
(iii)	Over Rs. 15,000 upto Rs. 25,000	13.5	13.5
(iv)	Over Rs. 25,000 upto Rs. 50,000	14.0	14.0
(v)	Over Rs. 50,000 and upto Rs. 2 lacs	15.0	15.0
(viA)	Over Rs. 2,00,000	15.0 Minimum	
(viB)	Over Rs. 2,00,000 and upto Rs. 7.5 lacs	—	16.5
(vii)	Over Rs. 7.5 lacs	—	18.0

HOW YOU GET YOUR LOAN

The flow chart for getting credit assistance is given below.

Decide your requirement and apply to

Commercial Bank (Service Area Branch) | Land Development Bank | Regional Rural Bank

May sanction and apply to National Bank

Technical Appraisal | Financial Appraisal

Sanction to Bank

Sanction to Beneficiary

Documentation

Security

Crop Hypothecation | Land Mortgage

Release loan in instalments

Repayment

Interest | Principal

When sufficient income generates

Loan Paid

Prosperity

Annexure-1

MODEL PROJECT FORMAT

1. **Introduction:** Nature of activity proposed to be promoted, its importance to the economy, employment potential and growth prospects etc.
2. **Location of the Project Area:** Block/Village; locational advantages, Land utilisation data of the project area.
3. **Technical Aspects of the Project:**
   (A) ***Agro-Climatic Conditions*** :- Monthwise average rainfall, maximum and minimum temperature, relative humidity, type of soil, their depth, pH value, topography and other physical features etc.
   (B) ***Cultural Practices*** :- Package of practices for cultivation, process, steps for distillation and further value addition products.
   (C) ***Production Schedule And Yield.***
4. **Marketing Aspects:** Indicate market for produce, price trend, market tie-up made or proposed to be made.
5. **Physical Programme :** Yearwise programme of execution in terms of acreage or number of units.
6. **Financial Programme :** Details of project cost, itemwise cost viz. Land preparation, Layout, planting material, planting, manures & fertilizers and their application, irrigation, interculture operations, plant protection, fencing, components of distillation unit etc.
7. **Source of Funds :** Borrower contribution, bank loan etc.
8. **Financial Analysis :** Cost-Benefit ratio and IRR.
9. **Repayment Schedule:**

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TECHNOLOGY TRANSFER IN ESSENTIAL OIL-BEARING PLANTS: RETROSPECTS AND PROSPECTS

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ABSTRACT

With the rapid growth of S&T information in the area of cultivation and processing of aromatic plants, an increasing trend was witnessed in movement of information from R&D institutions to the growers and enterpreneurs. This has become more important as every year, significant amount of foreign exchange is saved as well as earned through production apart from providing ample job opportunities, especially in rural sectors.

The activities on technology transfer are being geared up through extension and training-cum-demonstration programmes so that fruits of research could reach the farmers and enterpreneurs in a big way. Mechanism of technology transfer, its current status and future prospects are being discussed.

INTRODUCTION

Essential oil-bearing plants have been utilized in India for several thousand years. These are intermingled with our cultural heritage and old traditions. These have been frequently mentioned in our ancient literatures. Even today, these are the part and parcel of our daily life as we use them in different forms and at different occasions. Our country is also blessed with a wide variety of soil and climate to sustain and nurture the growth of various types of aromatic plants. In fact, India is perhaps the oldest center of human

civilization where method of distillation is reported to have been developed during 3000 B.C. (Indus Valley Civilization). However, systematic research work on essential oils started during first three decades of 20th century when industry based on Sandalwood, lemongrass, palmarosa, vetiver, etc. was established. These efforts got further boost with the constitution of Essential Oils Advisory Committee (Exploratory) in 1940 followed by Essential Oils Research Committee in 1941. On the recommendations of this Committee, a number of research schemes were financed by CSIR in the leading research centres and universities, the major ones being Indian Institute of Sciences, Bangalore, Forest Research Institute, Dehradun and H.B.T.I., Kanpur.

It was in the year of 1958, that the CSIR decided to open a separate institute named 'Central Indian Medicinal Plants Organization' (now 'CIMAP') specifically to work on the cultivation and processing on medicinal and aromatic plants with the primary aim of developing medicinal and aromatic plants-based industries in the country. The Institute started functioning with effect from 1959 and since then it had made significant contributions in the areas of development, popularization and transfer of agrotechnologies and processing technologies for the benefit of farmers and entrepreneurs.

CIMAP has focussed its attention towards the following different aspects over the past 30 years :

a) ***Development of improved agrotechnologies for indigenous essential oil-bearing plants***

e.g. lemongrass, palmarosa, vetiver, davana, rose, etc.

b) ***Introduction of exotic plants and development of agrotechnologies for their cultivation***

e.g. Japanese mint, peppermint, spearmint, bergamotmint, citronella Java, geranium, patchouli, lavender, clarysage and Bulgarian rose.

c) ***Screening of wild flora for commercial exploitation of essential oils***

e.g. Cedarwood, *Skimmia, Ferrula, Artemisia vestita, Cyperus* spp.

d) ***Development of processing technologies and know-how for value-added products***

e.g. distillation unit of directly-fired type for various essential oils, modern distillation process for rose oil, know-how for menthol, DMO processing, geraniol, citronellol, linalool, citral, Jasmine and tuberose concrete.

e) ***Development of improved varieties***

Under its genetic improvement programme CIMAP developed high-yielding varieties in various major essential oil-bearing plants which are very much popular among the growers.

f) ***Popularization and transfer of technologies***

CIMAP popularised its technologies among farmers and entrepreneurs through get-togethers, interaction with user industries, exhibitions, print and electronic media and more recently through training-cum-demonstration programme. Simultaneously, technologies were also transferred to both public and private sectors for commercial exploitation.

SERVICES OFFERED

CIMAP offers following services to growers and entrepreneurs under its marketing of R & D and services programmes -

i) Consultancy/technical services for cultivation and distillation/extraction.
ii) Transfer of process know-how developed.
iii) Testing and analysis of essential oil.
iv) Assistance to growers in marketing.
v) Survey of land and preparation of feasibility report.
vi) Supply of planting materials.
vii) Supply of engineering designs for pilot-plants, improved field distillation unit, etc.
viii) Training to growers, entrepreneurs and researchers.
ix) Supply of Farm Bulletins describing package of practices and economics of cultivation.

MECHANISM

As in other crops, transfer of technologies in the area of medicinal and aromatic plants involvs of getting the know-how out of the laboratory to the users in form of technical advice, documents, process, engineering designs and supply of planting material of

improved varieties developed by the laboratory. Depending upon the requirement of the client the technology would either be transferred on 'turn-key' basis at their site or it could be demonstrated in the laboratory followed by the supply of technology transfer documents (TTD). For licensing of know-how/process an agreement between the laboratory and the client is entered into wherein terms and conditions are specified. Above formalities are to be completed in case of process know-how or engineering technologies. However, in case of cultivation of aromatic plants, the farmers, may buy the planting material from the laboratory and start the cultivation of their own after seeking technical guidance. Consultancy Services can be rendered to the clients where these crops are intended to be grown for large scale processing. For all such services, the lumpsum payment or fee are realised depending upon the nature of service and its scope.

In any of the technology transfer system there is interaction among technology owner or transferor (laboratory), buyer or transferee (client/party) and financial institution or funding agencies. The role of later comes into picture if the entrepreneurs seeks financial assistance to start the cultivation and processing of medicinal and aromatic plants.

ADVANTAGES

The process of technology transfer, which has now become the popular modality of many countries, is growing fast since both the technology owner and the technology seeker get certain advantages. The owner of the technology, *i.e.* laboratory, accrue benefits through such technology transfer by increasing their return on R & D investment. This is also made obligatory on the part each CSIR laboratory to earn at least one-third of its operative cost every year. Other advantages to the laboratory through technology transfer have been to get the benefits from the technology which has no immediate use and also to get additional benefits from the technology which has already been utilized upto its limit. The buyers are benefitted by obtaining the technology which could be put directly into use at a little or no R & D investments and technical and financial risks are also quite low. Because of being agriculture-oriented (rural technologies) the transfer of technologies in essential oil-bearing plants does not offer much scope for substantial earnings to the laboratory. However, these technologies significantly con-

tribute to socio-economic development coupled with augmenting the production of essential oils which are used as raw materials in indigenous perfumery, cosmetic and flavour industries.

FUTURE PROSPECTS

The essential oil industry in country is expanding day-by-day and demand of the essential oils in the country is likely to increase every year. To increase the production for meeting internal demand as well as to export these oils in the world market, efforts will have to be accelerated for effective technology transfer in the country. It would have a significant impact on the economic development of the country. Some of the future prospects of technology transfer are described hereinunder -

Saving and earning of foreign exchange : Over the past 30 years, CIMAP has been instrumental in development and transfer of technologies for cultivation and processing of various such plants which were being imported into the country by spending considerable amount of foreign exchange. It is estimated that an amount of Rs. 61 crores has been saved as foreign exchange annualy by means of production of certain essential oils of mints, aromatic grasses, linaloe, geranium, lavender and rose, during 1991-92 (Table-1).

TABLE - 1.

Sl.No.	Item	Estimated Quantity produced (in tones)	Value in lakhs of Rs.
1.	Bergamot mint	20	30.00
2.	Citronella oil Java*	600	800.00
3.	Geranium oil	30	300.00
4.	Japanese mint oil	2,500	4,500.00
5.	Linaloe oil**	50	120.00
6.	Peppermint oil	40	100.00
7.	Rose oil	10 kg.	10.00
8.	Spearmint oil	80	240.00
	Total		6,100.00

*Jointly with RRL (Jorhat) and RRL (Bhubaneshwar)
**CIMAP and private entrepreneurs

With the increase in production of above essential oils it would be possible for the country to save more valuable foreign exchange in the coming years and at the same time more exportable surplus would also be created.

Among various essential oils produced in our country, palmarosa, lemongrass, sandalwood and ginger oils have substantial share in the world market. It has also been noted that Japanese mint oil and menthol have also made their presence felt in overseas market during the last 3-4 years. These are good indications that demand of Indian menthol would go on increasing. Perusal of export data from 1985-86 to 1990-91 indicate an increase in the export of essential oils from Rs. 16 crores to 38 crores though individual items has shown varying trends over the years (Table-2).

TABLE - 2 : Trend of Export & Import

Years	Export*	Import*
1985–86	1622.944	781.609
1986–87	2274.478	1534.264
1987–88	2172.544	1774.828
1988–89	2569.903	1946.903
1990–91	3815.750	2221.672

* Value in lakhs of rupees.

Source : Monthly Statistics of Foreign Trade of India

(Data for the year 1989-90 are not available)

The transfer and extensive application of improved technologies (high yielding varieties) by the farmers would result into increase in production both for domestic requirement as well as for export.

Generation of employment opportunities : Because of being labour intensive venture, the cultivation and processing of essential oil-bearing crops have tremendous potential for employment generation and poverty alleviation in rural sector. These crops could be fitted in the existing cropping pattern with very little capital investment and as such these are good candidates for rural development programmed. These crops also offers several self-employment opportunities such as raising of nursery and production and sale of seeds, large scale cultivation, distillation, collection and marketing and production of value-added products.

Wastelands utilization : Today. we are witnessing an acute pressure on good cultivable land on which various food, fibre and other traditional agricultural crops are being produced. Hence, it may be difficult to spare a large chunk of land for non-conventional crops such as medicinal/aromatic crops. However, some of these crops offer better prospects for utilization of the cultivable waste-lands in the country. Recently, crops like palmarosa, lemongrass, vetiver etc. have shown encouraging results under varieties of wastelands and technology transfer of such plants hold great promise in years to come.

CONSTRAINTS

Medicinal and aromatic crops are non-conventional crops and large number of growers and entrepreneurs are still not fully aware of their potential. Also, there are certain problems in marketing of the essential oils as growers and small scale distillers are reported to be exploited by big processing units/export houses or their agents, This is mainly due to lack of any Government policy to award support price for medicinal and aromatic plants. Complete data on production, supply and demand position are also not available. All these factors adversely affect the technology transfer programme in the present area.

CONCLUSION

We now have better expertise and infrastructure in the country and every effort should be made to make full use of them in technology transfer activities. Ample business opportunities are now available where package of practices are sought by the industries on turn-key basis. We will have to be more user responsive in this context. Also, frequent interactions among scientists, industries, growers and distillers are required which would facilitate us to understand the current trends and future needs of the industry and to plan the technology development and its/transfer accordingly. This would result in development of essential oil industry in a big way.

Proc. Explor. Indig. Raw Mat.
Ess. Oil Ind. (1992) : 151–155

भारतीय संस्कृति एवं सुगन्ध

– वीरेन्द्र चन्द्र सोती
'कमला कुटीर' 751/565, सुभाष नगर, इलाहाबाद।

भारतीय संस्कृति एवं सुगन्ध में परस्पर सम्बन्ध है। सुगन्ध का विशेष गुण यह है कि वह न केवल अपने प्रयोग करने वाले को अपनी भीनी मनमोहक महक से प्रसन्न चित्त करती है वरन् समस्त वातावरण को सुगन्धित और सुरभित बना देती है।

भारतीय संस्कृति का मूल मतन्वय मानव को श्रेष्ठ अथवा शिष्ट व्यक्ति बनाना है। उसे आचारवान की श्रेणी में लाना है। अच्छा आचार एवं स्वभाव सुरभिपूर्ण सुगन्ध की तरह होता है शिष्ट मनुष्य अपने शिष्ट आचरण से सर्वत्र एक सुहावनी सुगन्ध छोड़ देता है। उसके इस गुण से उसका सब जगह प्रभाव जम जाता है। इस सम्बन्ध में महाकवि कालिदास की यह सूक्ति अत्यन्त सटीक है :

पदं हि सर्वत्र गुणैर्निधीयते।

–रघुवंश 3. 62

–गुण सर्वत्र अपना प्रभाव जमा देते हैं। इसी प्रकार सुगन्ध भी प्रत्येक स्थान पर अपना प्रभाव प्रदर्शित कर देती है। जो स्त्री–पुरुष सुगन्ध को सूंघने से उसके सम्पर्क में आते हैं वे उससे अभिभूत हो जाते हैं। शिष्ट व्यक्ति अपने सदाचरण से न केवल अपने प्रति दूसरों की सद्भावना एवं सहानुभूति प्राप्त कर लेता है वरन् वह अपने सद्व्यवहार की ऐती सुगन्ध छोड़ देता है जिससे उस का सब आदर करते हैं ऐसे ही सुगन्ध भी सब की प्रशंसा का पात्र होती है।

महात्मा गांधी जैसे मनीषियों के सुकर्म की सुवास से सारा संसार सुवासित रहता है। ऐसे शीलवान् विभूतियों के सत्कर्मों एवं आदर्शों का प्रभाव चतुर्दिक सुगन्ध की तरह सहज रूप से फैल जाता है। उस सुगन्ध से सामान्य मानव–प्राणी अनुप्राणित हो उनके सिद्धान्तों एवं शील का अनुसरण करते हैं।

बौद्ध धर्म से सम्बन्धित धम्मपद में शील को सर्वोत्तम गन्ध माना गया है :

सील गन्धो अनुत्तरों

– धम्मपद 4. 12

इस प्रकार संस्कृति और सुगन्ध में सराहनीय साम्य है। भारतीय संस्कृति के प्रख्यात स्मृतिकार मुनिवर मनु का कथन है :

आचारः परमो धर्मः

– मनुस्मृति 1. 108

आचार ही परम् धर्म है। इसी प्रकार आवश्यक तेलों में देखा जाय तो सुगन्ध युक्त इत्र ही सर्वोपरि है।

यहां यह उल्लेखनीय है कि संस्कृति की मर्यादा के अन्दर चलना ही सदाचरण है। इसी तरह शालीनता की मर्यादा के तहत ही सुगन्ध का प्रयोग करना श्रेयस्कर है। सुगन्ध या इत्र को प्रायः विलासिता एवं रसिकता से जोड़ा जाता है परन्तु ऐसा नहीं है। सुगन्धित चन्दन का पूजा–अर्चना के उपरान्त मस्तक पर टीका लगाना तथा महिलाओं द्वारा सुगन्धित पदार्थों से अपने शरीर पर उपटन लगाना पुरातन काल से हमारी संस्कृति का अंग है।

प्रत्येक मनुष्य का शिष्टाचार या व्यवहार ही बताता है कि वह कितना सुसंस्कृत या सभ्य है। इसी प्रकार ब्यक्तियों द्वारा सुगन्ध का प्रयोग ही इस बात को संकेतित करता है कि उन्हें कितना सौन्दर्य–बोध है। वे कितने सौदर्योपासक या शौकीन मिज़ाज हैं ? कितने तहज़ीबयाफ्ता या अदब करने वाले हैं। जिस प्रकार संस्कृति सद्गुणों की प्रेरक है और अनुचित आचरण करने की अनुमति नहीं देती उसी प्रकार सुगन्ध भी जीवन को अधिक सरस और सौंदर्यमय बनाने को अनुप्राणित करती है। तथा दुर्गन्ध को रोककर उसका निषेध करती है।

भारतीय संस्कृति की अपनी स्वयं की गरिमा एवं महत्ता है इसी प्रकार सुगन्ध का भी अपना गौरवमय गुण है – सबको सुगन्धित करना।

सम्राटों एवं साम्राज्ञियों तक के द्वारा प्रयोग होने का सौभाग्य होने पर सुगन्ध इतराती नहीं। उसे अहंकार छू तक नहीं गया है। इसी प्रकार जो भारतीय संस्कृति से वास्तविक रूप से अभिप्रेरित रहते हैं वे अहंकार एवं गर्व से दूर रहते हैं। विख्यात विदुर–नीति के प्रणेता विदुर जी कौरवों के महामंत्री होते हुए भी अहम् भाव को त्याग कर एक साधारण सी कुटिया में रहते थे।

भारतीय संस्कृति के मूर्तिमान चाणक्य यद्यपि सम्राट चन्द्रगुप्त के राज्य में महामात्य के सर्वोच्च पद पर नियुक्त थे परन्तु अहंकार से परे थे और उन्हें अपने पद का मद लेशमात्र भी न था। वह एक अत्यन्त साधारण पर्ण–कुटीर में रहते थे।

राष्ट्रपिता होते हुए भी इसी सादा जीवन एवं उच्च विचार के प्रतीक महात्मा गांधी गर्व एवं अहं भाव से बिल्कुल दूर थे।

भारतीय संस्कृति में पांच प्रकार की योनि बताई गई है : उद्भिज, स्वेदज, अंडज, जरायुज एवं मनुष्य। सब जीव–जन्तु और प्राणी इन्हीं पांच योनियों के अन्तर्गत आते हैं।

जहां तक उद्भिज योनि का प्रश्न है उसमें फूलदार व सुगन्धित पौधे, वृक्ष तथा धातुएं जैसे हीरा, नीलम एवं पुखराजादि आते हैं। इस प्रकार सुगन्धित वस्तुएं उद्भिज योनि के क्षेत्र में आती हैं। मनुष्य योनि को सर्वोत्तम माना गया है। अतएव उसे छोड़कर जो दूसरी महत्वपूर्ण योनि मानी गई है वह सुगन्धित पदार्थों से सम्बन्धित उद्भिज योनि है।

भारतीय संस्कृति का एक मुख्य तत्व निष्काम भाव से शुभकर्म करना है। कृष्ण जी ने भगवद् गीता में इस विषय की विस्तृत व्याख्या कर उस पर अत्यधिक बल दिया है। सुगन्ध भारतीय संस्कृति के इस तत्व का अक्षरशः अनुपालन करती है। सुगन्ध एक अत्यन्त अनुकरणीय निःस्पृह, निष्काम एवं स्वार्थ–रहित कर्म करती है। इसी सन्दर्भ में कहा जा सकता है कि कस्तूरी की सुगन्ध दूसरों को तो प्रसन्न–चित्त करती है परन्तु कस्तूरी का तो इससे कुछ स्वार्थ सिद्ध नहीं होता। इस प्रकार निःस्वार्थ एवं निष्काम रूप से दूसरों की भारतीय संस्कृति के आधार पर सेवा करना सुगन्ध का एक सराहनीय गुण है।

भारतीय संस्कृति का एक अन्य महत्वपूर्ण आदर्श सुगन्ध सम्बन्धी इस गुण से प्रकट होता है :

सुजनों न याति वैरं परहित नितो विनाश कालेअपि।
छेयेअपति चन्दन तरुः सुभयति मुख कुठारस्य।।

– परोपकारी सज्जन विनाश काल आने पर भी शत्रुता नहीं रखते। देखिए न, काटने पर भी चन्दन का पेड़ कुल्हाड़ी के मुख को सुगन्धित ही करता है।

इस कथन की पुष्टि एक अन्य श्लोक से इस प्रकार होती है :

घृष्टं घृष्टं पुनरपि पुनश्चंदनं चापरु गन्ध,
छिन्न–छिन्न पुनरपि पुनः स्वादुचैवेक्षुदण्डम् ।

दग्धं दग्धं पुनरपि पुनः काच्चनं कान्तवर्ण,
न प्राणान्ते प्रकृति विकृतिजयिते सज्जनानाम् ।।

चाहे कितना ही घिसें, चंदन सुगन्ध ही देता है, चाहे दाँतों से कितना ही काटें गन्ना मीठा ही रहता है, चाहे आग से कितना ही जलायें, सोना चमचमाता ही रहता है – प्राणांत में भी सत्पुरुषों का स्वाभाव बदलता नहीं।

वराहमिहिर – 550 – 587 ई. को भारत के अद्वितीय ज्योतिषी होने का गौरव प्राप्त है। वह सम्राट विक्रमादित्य की राजसभा के सर्वोत्तम चिकित्सक धन्वन्तरि, कवि शिरोमणि कालिदास तथा अमरकोष के प्रणेता अमरसिंह जैसे नवरत्नों में से एक थे।

वराहमिहिर का पश्चसिद्धान्तिका नामक ग्रन्थ अत्यंत प्रसिद्ध है। अपने इस ग्रन्थ में पैतामह, रोमक, पौलिस, सूर्य और वशिष्ठ इन पांच सिद्धान्तों के विषय में इन्होंने लिखा है। इन्होंने ग्रहों के संयोग को ग्रहण का कारण नहीं माना है। इन्होंने चार हजार 2 श्लोकों का एक वृहद ग्रन्थ, जो "वृहद संहिता" के नाम से विख्यात है, रचा। यह ग्रन्थ सौ अध्यायों में विभक्त है इनमें से पचास ज्योतिष शास्त्र से सम्बन्धित हैं। शेष अन्य वैज्ञानिक विषयों से। इस प्रकार यह ग्रंथ केवल ज्योतिष शास्त्र ही नहीं वरन् विज्ञान संबन्धी अनेक विद्याओं का एक कोष (भंडार) है। वैसे तो अथर्ववेद में अनेक मंत्र पाए जाते है। जो जड़ी– बूटियों के प्रयोग के साथ–साथ कष्टों के निवारणार्थ गाए जाते थे। परन्तु वृहद् संहिता की यह विशेषता है कि इस ग्रन्थ में वराहमिहिर ने जड़ी–बूटियों के मिश्रण से सैकड़ों प्रकार की सुगन्ध बनाने की विधियां "गन्ध युक्ति" अध्याय में बताई है।

श्री श्याम नारायण कपूर ने जुलाई 1990 के नवनीत अंक में अपने लेख "महान वैज्ञानिक वराहमिहिर" में इस विषय पर जो लिखा है उसे साभार यहां दिया जा रहा है :

"मोथा, नेत्रबाला, शैलेय, खस, कचर, ब्याघ्रनख, नाग केसर के फूल, नख, स्पृक्का, अगरु, मदनक, तगर, धनिया, कपूर, चौरक और श्वेत चन्दन इन सोलह द्रव्यों में से किन्हीं चार के क्रम से एक भाग और चार भाग अदल–बदल कर चूर्ण बनाने से गंधार्णव नामक छियान्नबे तरह के सुगन्ध द्रव्य तैयार होते हैं। धनिया और कपूर में बहुत तेज़ गन्ध होने के कारण धनिया का एक भाग और कपूर का एक भाग से भी कम डालना चाहिए। इन सोलह द्रव्यों के चार–चार विकल्प से 1820 प्रकार की सुगन्ध बनेगी"

"मंजीठ, समुद्रफेन, श्रूक्ति यानी सीपी, दाल चीनी, कूट और बोल इन सबको बराबर लेकर चूर्ण करें तथा उस चूर्ण को तिल के तेल में डाल कर धूप में तपायें। इस तेल में चम्पे के फूलों जैसी गन्ध आ जाती है। इसीतरह मौल श्री, नील कमल, अतिमुक्त पुष्पों की गन्ध बनाने के भी नुसखे दिये हैं।"

"सफेद बाल काले करने, कई प्रकार के मुखवास, स्नान के लिए चूर्ण और चौरासी प्रकार के केसर – गन्ध बनाने के नुसखे .... बतलाये हैं।"

यहां इस सबको लिखने का अभिप्राय यह है कि जिस प्रकार भारतीय संस्कृति के मूल सिद्धान्तों का अनुसरण करने पर यथार्थ संस्कृति–सम्पन्न श्रेष्ठ व्यक्ति का निर्माण होता है ठीक उसी प्रकार मूल जड़ी – बूटियों पर आधारित सुगन्ध बनाने की प्रक्रिया अपनाने पर वास्तविक श्रेष्ठ सुगन्ध का उसके प्राकृतिक स्वरूप में उत्पादन होता है। यह प्राचीन संस्कृति की भांति नैसर्गिक सम्मोहक सुगन्ध होती है। इसके विपरीत जैसे आजकल आधुनिकता की आड़ में पाश्चात्य संस्कृति के चतुर्मुखी प्रभाव के कारण भारतीय संस्कृति अपने मूल तत्वों से दूर हो

रही है जिससे भारतीय जीवन एक प्रकार से कृत्रिम बना दिया गया है, वैसे ही अब सुगन्ध या इत्र–फुलेल तैयार करने में पाश्चात्य प्रणाली पर आधारित पुष्पों की मौलिक गन्ध के रासायनिकीकरण के बाद "सेंथेटिक परफ्यूम" द्वारा कृत्रिम सुगन्ध का निर्माण हो रहा है। यह शुद्ध असली सुगन्ध नहीं बल्कि बनावटी नकली सुगन्ध है। यह वह आत्मिक तुष्टि प्रदान नहीं कर सकती जो सीधे पुष्पों या जड़ी–बूटियों से बनी सुगन्ध करती है। एक अनुमान के अनुसार एक पौंड शुद्ध सुगन्ध बनाने के लिए लगभग 1769 पौंड या 12 लाख 25 हजार पुष्पों की आवश्यकता पड़ती है।

प्राचीन भारतीय संस्कृति में पाश्चात्य संस्कृति से प्रभावित आधुनिक भारतीय संस्कृति में जो अन्तर है वही वराहमिहिर द्वारा प्रतिपादित सुगन्ध निर्माण करने की पद्धति और सेंथेटिक रूप से निर्मित कृत्रिम सुगन्ध में फर्क है। यह आधुनिकता निश्चित रूप से भारतीय संस्कृति सम्बन्धी तत्वों की पहचान का धीरे–धीरे सफाया कर रही है और परम्परागत धार्मिक प्रथाओं से दूर ले जा रही है। उसी प्रकार सेंथेटिक ढंग से बनी नकली सुगन्ध सीधे पुष्पों और जड़ी–बूटियों के रस से निर्मित असली सुगन्ध की आत्मा का हनन कर उसका सफाया कर रही है।

रासायनिक प्रयोगों द्वारा प्राप्त सेंथेटिक सुगन्ध क्षणिक एवं अनुपयोगी होती है बल्कि जीवन के लिए उपयोगी एवं आवश्यक होती है। वह औषधि का काम करती है। उदाहरण के लिए केवड़े की सुगन्ध को लिया जा सकता है। जल में केवड़े के फूल डालने से जो प्राकृतिक सुगन्ध होती है वह पानी के गुण को ही बदल देती है किन्तु रासायनिक रूप में निर्मित इत्र की मात्रा के कुछ अधिक हो जाने पर पानी में कड़वाहट आ जाती है। यही अन्तर आज भारतीय संस्कृति पर भी पाश्चात्य संस्कृति के प्रभाव का है जिसने हमारी संस्कृति ही नहीं बदल दी है वरन् जीवन प्रणाली में विषमता उत्पन्न कर दी है। भारतीय परिवेश में वह संस्कृति न तो गुणकारी हो सकती है और न उपयोगी।

Proc. Explor. Indig. Raw Mat.
Ess. Oil Ind. (1992) : 156–160

पोदीने के तेलों की सफल गाथा

भगीरथ बयानी
भारत फाइन इन्डस्ट्रीज, बम्बई।

जापानी पोदीने की खेती का भारत में इतिहास काफी उत्साह वर्धक है ज़ो 60 के दशक से प्रारम्भ हो कर आज अपने विकास की उस सीढ़ी पर पहुंच चुका है जहां उसने इस क्षेत्र में विश्व के देशों में भारत के महत्व को स्थापित किया है।

द्वितीय विश्व युद्ध के बाद का जापानी पोदीने का इतिहास

द्वितीय विश्व युद्ध से पूर्व हालॉकि चीन में कई वर्षों से इसकी खेती होती थी। पर मुख्यतः जापान में औद्योगिक स्तर पर पौधे से तेल एवं मैथॉल का उत्पादन होता था, परन्तु द्वितीय विश्व युद्ध के दौरान प्रथम तो कृषि योग्य भूमि के अभाव में, दूसरे जापान एवं संयुक्त राष्ट्र अमरीका के बिगड़े सम्बन्धों के कारण इसकी खेती बन्द हो गई। इन सब कारणों के बाद भी आज तक जापान प्राकृतिक एवं कृत्रिम मैथॉल के उत्पादन में विश्व में अग्रणी देश है।

इसी बीच 1940 के दशक के दौरान ब्राजील में जंगलों को साफ कर जापानी पोदीने की खेती का प्रचलन हुआ और तीव्र गति से फैला। इस प्रकार 50 से 70 के दशकों में जापानी पोदीने के तेल एवं इसके उत्पादों में ब्राजील अग्रणी देश बना। तत्पश्चात् इसकी खेती का स्थान अन्य लाभकारी उत्पादों जैसे काफी, कोका आदि ने ले लिया। वर्तमान में ब्राजील को पोदीने के तेल के व्यापार के लिए पड़ोसी देश परागुए पर निर्भर रहना पड़ रहा है।

70 के दशक में हुई कृषि क्रांति एवं ब्राजील में पोदीने की खेती में कमी के कारण चीन में इसकी खेती का शीघ्रता से प्रसार हुआ। इसी दौरान भारत में भी जापानी पोदीने की खेती ने अपनी जड़ें जमानी शुरू कीं जो 80 के दशक तक पहुंचते ही बड़े उद्योग का स्वरुप ले चुकी थीं।

इसी दौरान कुछ स्वार्थी तत्वों द्वारा तेल के निर्यात एवं मेन्थाल के आयात आदि के कारण हुई मूल्यों में गिरावट के कारण यह एक अलाभकारी व्यवसाय बन गया और किसानों ने जापानी पोदीने की खेती बन्द कर दी।

उधर 80 के दशक के शुरुआत में चीन ने जापानी पोदीने के उद्योग में अपना वर्चस्व स्थापित किया और ब्राजील के तेल के स्थान पर यहां का मेन्थाल रहित तेल सुगन्धों में मानक के स्वरुप में प्रयुक्त होने लगा।

1984 में विश्व बाजार में इसकी बढ़ती मांग की पूर्ति चीन द्वारा न की जाने के फलस्परुप भारतवर्ष को एक सुनहरा अवसर प्राप्त हुआ परन्तु भारत इसका लाभ न उठा सका क्योंकि यहाँ इसका उत्पादन कम हुआ था परन्तु दिन प्रतिदिन की बढ़ती मांग को पूरा करने हेतु भारत को इसका आयात भी करना पड़ा।

जब 1984 में किसानों को अपने उत्पादन का उचित से अधिक लाभ मिला तो इससे प्रोत्साहित होकर और अधिक भूमि पर जापानी पोदीने की खेती की जाने लगी और 1985 में पैदावार दोगुनी हो गई। इसके पश्चात इस क्षेत्र में जापानी पोदीने की नई किस्म MAS-1 का पदार्पण हुआ जिसके तेल से 40% अधिक मेन्थाल प्राप्त होता था। इसके पश्चात् शैवालिक किस्म के आ जाने से तो इस क्षेत्र में क्रांति आ गई जिसके तेल की पैदावार सामान्य से दोगुनी थी।

जापानी पोदीने के तेल के मूल्य दृढ़ता के कारण एवं खेती में उत्तरोतर वृद्धि के फलस्वरुप 1990 में 1989 की तुलना में दोगुनी खेती हुई और अधिकतर किसानों ने शैवालिक किस्म का प्रयोग किया। केवल उत्तत प्रदेश एवं पंजाब में ही 50,000 एकड़ भूमि में जापानी पोदीने की खेती हुई। फसल के दौरान इसके तेल का मूल्य 200/= रु. प्रति किलो रहने के फलस्वरुप जापानी पोदीने के तेल का लगभग 80 करोड़ का व्यापार हुआ।

पिपरमेन्ट एवं स्पियरमेन्ट के तेल के क्षेत्र में भी हमारा देश आत्मनिर्भर है यही नहीं विदेशों को भी निर्यात करता है। वर्ष 1990 में इन तेलों का लगभग 6 करोड़ का व्यापार हुआ। एक अन्य पोदीना मे. सिट्रेटा का भी लगभग आधे करोड़ का व्यापार हुआ इस प्रकार वर्ष 1990 में पोदीने के विभिन्न तेलों से सम्बन्धित उद्योगों ने लगभग 90 करोड़ रु. का व्यापार किया।

प्राकृतिक एवं कृत्रिम मेन्थाल की 1981 में कुल खपत (सुगन्ध, स्वाद, दवाइयों, तम्बाकू एव स्वास्थ्य वर्धक औषधियों में)
(साभार परफ्यूमर्स एवं फ्लेवरिस्ट वर्ष 1988 भाग 13)

उत्तरी अमरीका	1,500 टन
योरप (पूर्वी ब्लाक सहित)	1,200 टन
एशिया (इंडोनेशिया, फिलीपीन, जापान)	1,700 टन
दक्षिण एवं केन्द्रीय अमरीका,	700 टन
अन्य (आस्ट्रेलिया, न्यूजीलैन्ड एवं पूर्वी अफ्रीका)	500 टन
योग	5,600 टन

इस तालिका में चीन और रूस की खपत शामिल नहीं है और उसके योग के पश्चात् अनुमानित खपत 7,000 मिट्रिक टन के बराबर होगी।

वर्ष 1990 में जापानी पोदीने के तेल एवं मेन्थाल का उत्पादन

	तेल उत्पादन	समकक्ष मेन्थाल
चीन	7000 टन	4200 टन
	(5000)	(3000)
भारत	3600	2,200
	(2000)	(1,200)
परागुए	700	300
	(500)	(200)
कृत्रिम	2000	1800

इस तेल के उद्योग की अपेक्षता देखने के लिए आइए खेतों से तेल का मूल्यांकन करें।

जापानी पोदीने के तेल	प्रति एकड़ पहली फसल	मूल्यांकन दूसरी फसल
तैयारी एवं बीज	1000	–
खाद एवं रसायन	1000	200
सिंचाई	500	250
निराई	750	1000
कटाई	350	350
ढुलाई एवं आसवन	300	300
कुल खर्च	3900	2100

इसमें भूमि अधिग्रहण व्यय 1000 जोड़ने पर कुल खर्च = 7000

सामान्य आसवन व्यय =30 प्रति किलो

प्रति एकड़ 2 कटाइयों का उत्पाद	प्रति किलो तेल का मूल्य		रु./कि.
जापानी पोदीना का तेल	70/किलो	(7000/70) + 30	130
पिपरमेन्ट तेल	25	(7000/25) + 30	310
स्पियरमेन्ट तेल	35	(7000/35) + 30	230
सिट्रेटा तेल	30	(7000/30) + 30	263

जापानी पोदीने के अतिरिक्त अन्य तेलों के क्षेत्र में जब तक उनकी उन्नत किस्में प्रयोग में नहीं लाई जातीं, उनका निर्यात लाभप्रद नहीं हो सकता। तेल मूल्य 150 रु. प्रति किलो होने से खेती में वृद्धि होगी अन्यथा कम होगी। पोदीने की खेती से होने वाली आय दूसरी फसलों से होने वाली आय के मुकाबले अधिक होने पर इसका उत्पादन बढ़ सकता है।

अर्जित सफलता को बनाए रखना हर सफलता की एक कहानी होती है। इसके कुछ सुनहरे पहलू भी होते हैं एवं नाटकीय उतार चढ़ाव भी।

जापानी पोदीने की सफलता से भी कुछ शिक्षा मिलती है। चीन को अपवाद रहने दें तो यह स्पष्ट है कि जापान, ब्राजील एवं ताइवान जहाँ सफलतापूर्वक इसकी खेती की जाती थी वर्तमान में लगभग लुप्त है भारत ने इस सफलता को देर से अर्जित किया है अब यह देखना है कि कब तक इस सफलता को स्थायी रख पाता है।

मुख्यतः इस उद्योग की जड़े मजबूत करने हेतु इसकी खेती में ज्यादा पैदावार तथा थोक माल एवं उसके प्राप्त करने की तकनीक में सुधार लाकर सस्ता एवं उच्च श्रेणी का माल पैदा करना है।

ध्यान देने योग्य बात है कि हमें क्यों 1988 में सफलता मिली और 1984 में नहीं जबकि दोनों वर्षों में विश्व के बाजार में माल के दामों में पर्याप्त वृद्धि हुई थी। वास्तव में 1979 में सुगन्ध तेलों के निर्यात की एक गोष्ठी में विदेशी पर्यवेक्षकों ने भारतीयों को इस क्षेत्र में आने को प्रेरित किया और हमने सफलता भी प्राप्त की जबकि हमारे तेल की मानकता भिन्न थी।

डिमेन्थोलाइज्ड (मेन्थाल रहित) तेल :- उस समय तेल का बेकार हिस्सा समझा जाता था जबकि विश्व व्यापार में उसका अपना उपयोग था। मेन्थाल रहित तेल का विश्व व्यापार में अच्छा मूल्य था। भारत में जापानी पोदीने के मुख्य अवयव के मूल्य के साथ उसके तेल के मूल्य में उतार चढ़ाव आता था। मेन्थाल रहित तेल के लिए विश्व बाजार में केवल उस दशा में सम्भावना थी जब वह कुछ सौ टनों में उपलब्ध हो। विश्व बाजार में भारत की जापानी पोदीने की खेती की सम्भावनाएं बढ़ीं उसी समय अग्रिम लाइसेन्स द्वारा आयातित मेन्थाल के कारण 80 के दशक के आरम्भ में कुछ गिरावट भी आई यह सब उन लोगों के कारण हुआ जिन्हें वास्तव में इस उद्योग से लगाव नहीं था। इन सब परिस्थितियों के बावजूद 1988 में इस उद्योग की जड़ें और मजबूत हुई। हमें पिछले तीन वर्षों के आकड़े दर्शाते हैं कि खेती के क्षेत्रफल में वृद्धि हुई व उच्च किस्मों का प्रयोग किया गया है।

इस उद्योग की समृद्धि के मुख्य उपायों के निहित उच्च श्रेणी के बीज (Planting material), खेती, आसवन एवं (Processing) तकनीकों का प्रयोग परम आवश्यक है। साथ ही माल के गुणों में समानता एवं मानकीकरण की आवश्यकता है रोज़- रोज़ नई-नई किस्मों के प्रयोग से माल के गुणों में परिर्वतन अवश्यम्भावी है।

मानकीकरण द्वारा किसी नई किस्म के मानक मापदण्ड उसकी खेती द्वारा agronomical trials करें तथा वातावरण के अनुकूल बनाकर स्थापित किये जा सकते हैं। शैवालिक किस्मों का भी मानकीकरण अभी होना बाकी है। अभी भी कृषि तकनीकों के विकसित करने की गुंजाइशें हैं जिनके द्वारा उत्पादन एवं गुणवत्ता में वृद्धि हो सकती है। फसल के पकने एवं कटने के उचित समय के बारे में जानकारी भी किसानों एवं कृषि विशेषज्ञों की सहायता से प्राप्त हो सकती है। शैवालिक किस्म की खेती इतनी रही कि दूसरे ही वर्ष में इसने पूरा क्षेत्र अपना लिया। परन्तु विभिन्न स्थानों से प्राप्त तेल के गुणों में काफी अन्तर पाया गया। शैवालिक किस्म के उचित विस्तार हेतु कृषि विशेषज्ञों द्वारा उसका मानकीकरण परम आवश्यक है।

पिपरमेन्ट भी इसी दुखी दौर से गुज़र रहा है। बिगड़ती किस्म एवं तेल के प्रतिशत में कमी इसके बीज के स्तर में गिरावट के लक्षण हैं। कुछ दशक पूर्व ब्लैक मिकेम किस्म के पश्चात् आज तक इसकी किसी भी नई किस्म का विकास नहीं हुआ। 80 के दशक में विकसित रूसी पिपरमेन्ट में भी जापानी पोदीने के गुणों का बाहुल्य था। वर्तमान पिपरमेन्ट की किस्म में परम सुधार की आवश्यकता है या किसी नई किस्म का आयात कर उसका व्यापारिक स्तर पर उत्पादन किया जाये। भारतीय सुगन्ध तेल संघ के आह्वाहन पर कुछ दिन पूर्व बदाँयू एवं बाजपुर में किसानों एवं कृषि विशेषज्ञों की एक गोष्ठी आयोजित की गई थी जिसके अनुसार मृदा, जल आदि का परीक्षण कर उनमें निहित कमियों का पता लगाया जा सकता है जो इन किस्मों के गुणक्षय के जिम्मेदार हैं।

विकसित एवं आयातित किस्में

जापानी पोदीने के उन्नत किस्मों के विकास के क्षेत्र में भी सीमित कार्य हुआ है। CIMAP, लखनऊ एवं NBPGR, दिल्ली का इसमें सराहनीय योगदान है। पिछले दो दशकों में CIMAP द्वारा MAS–1 का सफलतापूर्वक औद्योगिक विस्तार हुआ। परन्तु एक निजी प्रयास द्वारा चीन में उगाई जाने वाली जापानी पोदीने की किस्म से विकसित शैवालिक किस्म ने शीघ्र ही इसका स्थान ले लिया। दूसरी पोदीने की उन्नत एवं सफल किस्म स्पाइकेटा की है जिसका उत्पादन क्षेत्र में प्रवेश लगभग 5 वर्ष पूर्व हुआ था। हमें पोदीने के तेल एवं इससे प्राप्त सुगन्ध रसायनों के व्यापार में सफल स्पर्धा अर्जित करने हेतु पोदीने की पिपरेटा, स्पाइकेटा एवं सिट्रेटा प्रजातियों का विकास करना होगा।

उन्नत किस्मों के विकास के क्षेत्र में breeding द्वारा पर्याप्त कार्य किया जा रहा है। अधिक क्षमता वाली किस्मों का आयात, उनमें सुधार एवं व्यापारिक स्तर पर उत्पादन ही देश में पोदीने के तेल के व्यवसाय को विश्व में अपना स्थान बनाए रखने के लिए आवश्यक है। वर्तमान में उगाई जाने वाली पिपरेटा एवं सिट्रेटा की किस्में विश्व बाजार में अपने उत्पाद के गुण एवं उत्पादन में अपेक्षा से निम्न है। नई किस्म की पहचान (Locating) एवं आयात भी एक सरल कार्य नहीं है।

योरप एवं अमेरिका से हमें पोदीने की पिपरेटा, स्पाइकेटा या सिट्रेटा नस्लों की उन्नत किस्में प्राप्त हो सकती हैं। इनके विस्तार में हमारी राष्ट्रीय प्रयोगशालाएं सहायक होंगी। किसानों एवं उद्योगपतियों के परस्पर सहयोग से इन उन्नत किस्मों का व्यापारिक स्तर पर लाभ उठाया जा सकता है।

भारत में पोदीने की खेती का अल्प समय में ही बहुत विकास हुआ है। इस सफलता को आगे ले जाने हेतु इसके विकास एवं निर्यात सम्बन्धित प्रयासों की आवश्यकता है। हमें उचित आकड़ों एवं तथ्यों की आवश्यकता है अनुमान की आवश्यकता नहीं है। हमें प्रारम्भ से ही योजनाबद्ध अनुसन्धान प्रयासों के साथ इसकी खेती का विस्तार दूसरे क्षेत्रों में करना होगा, जिससे इसके उत्पादन में स्थिरता आये एवं किसानों को भी अन्य फसलों के मुकाबले ज्यादा लाभ हो और विश्व बाज़ार में हमारी स्पर्धा कायम रहे।